Supreme Court, U. S.
FILED
SEP 16 1980
MICHAEL RODAK, JR., CLERK

No. 80-418

In the Supreme Court of the United States

October Term, 1980

UNITED BUSINESS COMMUNICATIONS, INC.,
a Kansas Corporation,
Petitioner,

vs.

MILGO ELECTRONIC CORPORATION,
a Florida Corporation,
Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE TENTH CIRCUIT

WILLIAM H. CURTIS
(Counsel of Record)
1700 Bryant Building
Kansas City, Missouri 64106
(816 842-5910)

CARTER H. KOKJER
800 Ozark National Life Building
Kansas City, Missouri 64106
(816 474-5300)

JOHN F. DODD
2330 Johnson Drive
Shawnee Mission, Kansas 66205
(913 676-3000)

Attorneys for Petitioner, United Business Communications, Inc.

Of Counsel:

MORRISON, HECKER, CURTIS, KUDER & PARRISH
LOWE, KOKJER, KIRCHER, WHARTON & BOWMAN

E. L. MENDENHALL, INC., 926 Cherry Street, Kansas City, Mo. 64106, (816) 421-3030

QUESTIONS PRESENTED

1. Is a trial court's conclusion of "obviousness" on patent validity under 35 U.S.C. § 103 a conclusion of law, calling for full and independent judicial review by a court of appeals, or is it merely a finding of fact to be reviewed under the "clearly erroneous" standard of Rule 52(a), Fed. R. Civ. P.?

2. May a court of appeals abdicate its appellate responsibilities by using the "clearly erroneous" standard of Rule 52(a) to limit appellate review of district court determinations based solely upon the application of legal principles to underlying findings of fact, when the findings of fact are not disputed on appeal?

3. May a patentee, despite 35 U.S.C. § 287, be awarded trebled infringement damages on the basis of "lost sales" for "sales" of accused devices which were made prior to the start of the infringement accounting period and even prior to issuance of the applicable patent?

4. Does a court of appeals fail to fulfill its appellate responsibilities when it affirms without explanation a district court determination of willful infringement for which there is no possible evidentiary or factual basis in either the underlying findings of fact or the record as a whole?

TABLE OF CONTENTS

QUESTIONS PRESENTED I
TABLE OF CONTENTS III
OPINIONS BELOW 1
JURISDICTION 2
THE STATUTES AND RULES INVOLVED 2
STATEMENT OF THE CASE 3
REASONS FOR GRANTING THE WRIT 8

I. The Court of Appeals Improperly Affirmed the District Court's Conclusion of Patent Validity 9

A. In Treating Obviousness As a Question of Fact, the Court of Appeals Employed an Improper Standard of Review of Patent Validity 9

B. The Claimed Subject Matter of the Whang '023 Patent Should Have Been Found Obvious in the Light of the Prior Art As a Whole 13

II. Certiorari Is Required to Assure Uniform Application of Rule 52(a) in an Area in Which It Has Been Applied Inconsistently Within and Between the Courts of Appeal 15

III. Certiorari Is Required to Protect the Integrity of 35 U.S.C. § 287 and to Assure Meaningful Appellate Review 22

CONCLUSION 24

APPENDIX—

Opinion of Tenth Circuit Court of Appeals (May 29, 1980) A1

Order of Tenth Circuit Court of Appeals Denying Rehearing (July 22, 1980) A43

PREVIOUS PAGE WAS BLANK

Findings of Fact and Conclusions of Law of the United States District Court (January 13, 1976) A45

Order to Correct Typographical Errors in Finding 89 (January 27, 1976) A126

Order Modifying and Supplementing Findings of Fact and Conclusions of Law (May 23, 1978) A152

Order Amending and Correcting Judgment and Entering Amended Judgment (June 13, 1978) A156

Excerpts From Bennett and Davey Text "Data Transmission" A161

Table of Authorities

CASES

Airlite Plastics Co. v. Plastilite Corp., 526 F.2d 1078 8th Cir. 1975), *cert. denied*, 96 S.Ct. 1672 (1976) 10

Anderson's-Black Rock v. Pavement Salvage Co., 396 U.S. 57 (1969) 10, 13

Armour & Co. v. Wilson & Co., 274 F.2d 143 (7th Cir. 1960) 10

Baumgartner v. United States, 322 U.S. 665 (1943) 16

Bendix Home Systems, Inc. v. Hurston Enterprises, Inc., 566 F.2d 1039 (5th Cir. 1978) 18

Berger v. Columbia Broadcasting System, Inc., 453 F.2d 991 (5th Cir. 1972) 18

Blohm & Voss AG v. Prudential - Grace Lines, Inc., 489 F.2d 231 (4th Cir. 1973), *cert. denied*, 419 U.S. 840 (1974) 10

Chicago Rawhide Mfg. Co. v. Crane Packing Co., 523 F.2d 452 (7th Cir. 1975) 10

Commissioner v. Duberstein, 363 U.S. 278 (1960) 16

Deering Milliken Research Corp. v. Beaunit Corp., 189 USPQ 565 (4th Cir. 1976) 10

DeWitt Truck Brokers, Inc. v. W. Ray Flemming Fruit Company, 540 F.2d 681 (4th Cir. 1976) 18

Dickstein v. Seventy Corp., 522 F.2d 1294 (6th Cir. 1975) 10
Dixon v. Process Corp., 382 A.2d 893 (Md. App. 1978) 17
Dual Manufacturing & Engineering v. Burris Industries, Inc., 619 F.2d 660 (7th Cir. 1980) 8, 10
Edwin K. Williams & Co. v. Edwin K. Williams & Co. - East, 542 F.2d 1053 (9th Cir. 1976) 18
E.F. Drew Co. v. Reinhard, 170 F.2d 679 (2nd Cir. 1948) 21
Empire Life Insurance Co. of America v. Valdak Corporation, 468 F.2d 330 (5th Cir. 1972) 23
Erie Technological Products, Inc. v. Die Craft Metal Products, Inc., 461 F.2d 5 (7th Cir. 1972) 10
E-T Industries, Inc. v. Whittaker Corp., 523 F.2d 636 (7th Cir. 1975) 10
Fall River Gas Appliance Co. v. C.I.R., 349 F.2d 515 (1st Cir. 1965) 20
Famous Knitwear Corp. v. Drug Fair, Inc., 493 F.2d 251 (4th Cir. 1974) 19
Fish v. East, 114 F.2d 177 (10th Cir. 1940) 19
Flour City Architectural Metals v. Alpana Aluminum Products, Inc., 454 F.2d 98 (8th Cir. 1973) 10
Gamble v. C.I.R., 242 F.2d 586 (5th Cir. 1957) 20
Garrett Corp. v. American Safety Flight Systems, Inc., 502 F.2d 9 (5th Cir. 1974) 10
General Electric Co. v. Wabash Appliance Corp., 304 U.S. 364 (1938) 15
G.M. Leasing Corp. v. United States, 514 F.2d 935 (10th Cir. 1975) 18
Gettelman Mfg., Inc. v. Lawn 'N' Sport Power Mower Sales & Service, Inc., 517 F.2d 1194 (7th Cir. 1975) 10
Glasson v. City of Louisville, 518 F.2d 899 (6th Cir. 1975) 19

Graham v. John Deere & Co., 383 U.S. 1 (1966) 9, 10, 11, 13, 14
Great Atlantic & Pacific Tea Co. v. Supermarket Equip. Corp., 340 U.S. 147 (1950) 15
Hadfield v. Ryan Equipment Co., 456 F.2d 1218 (8th Cir. 1972) 10
Hanna v. Plumer, 380 U.S. 460 (1965) 9
Hicks v. United States, 368 F.2d 626 (4th Cir. 1966) 19
Hollander v. Henry, 186 F.2d 582 (2nd Cir. 1951) 18
Joseph Lupowitz Sons, Inc. v. C.I.R., 497 F.2d 862 (3rd Cir. 1974) 19
Julie Research Laboratories, Inc. v. Guideline Instruments, Inc., 501 F.2d 1131 (2nd Cir. 1974) 10
Kilpatrick Bros., Inc. v. Poynter, 473 P.2d 33 (Kan. 1970) 17
Koppers Co., Inc. v. S & S Corrugated Paper Machinery Co., Inc., 517 F.2d 1182 (2nd Cir. 1975) 10
Mamiye Brothers v. Barber Steamship Lines, Inc., 360 F.2d 774 (2nd Cir. 1966) 19
Miller v. United States, 587 F.2d 991 (9th Cir. 1978) 19
Minnesota Mining and Mfg. Co. v. Berwick Industries, Inc., 190 USPQ 209 (3rd Cir. 1976) 10
National Bond Finance Company v. General Motors Corporation, 341 F.2d 1022 (8th Cir. 1965) 18
Nolan v. Sullivan, 372 F.2d 776 (3rd Cir. 1967) 19
Norfin, Inc. v. International Business Machines Corporation, No. 78-1620 (10th Cir. 1980) 11-12
O'Neill v. United States, 450 F.2d 1012 (3rd Cir. 1971) 19
Parker v. Motorola, Inc., 524 F.2d 518 (5th Cir. 1975) 10
Payne Metal Enterprises, Ltd. v. McPhee, 382 F.2d 541 (9th Cir. 1967) 10
Pederson v. Stewart-Warner Corp., 536 F.2d 1179 (7th Cir. 1976), *cert. denied*, 429 U.S. 985 10

Philips Industries, Inc. v. State Stove & Mfg. Co., 522 F.2d 1137 (6th Cir. 1975) 10
Quarles v. Fuqua Industries, Inc., 504 F.2d 1358 (10th Cir. 1974) 17
Raulie v. United States, 400 F.2d 487 (10th Cir. 1968) 23
Ruby v. American Airlines, Inc., 329 F.2d 11 (2nd Cir. 1964) 20
Rudolph v. United States, 370 U.S. 269 (1962) 24
Sakraida v. Ag Pro, Inc., 425 U.S. 273 (1976) 11, 13
Schlagenhauf v. Holder, 379 U.S. 104 (1964) 9
Schnadig Corp. v. Gaines Manufacturing Co., Inc., 494 F.2d 383 (6th Cir. 1974) 10
S.E.C. v. Texas Gulf Sulphur Co., 401 F.2d 833 (2nd Cir. 1969) 19
Shatterproof Glass Corp. v. Guardian Glass Co., 462 F.2d 1115 (6th Cir. 1972), *cert. denied*, 409 U.S. 1039 (1972) 10
Steinbrugge v. Haddock, 281 F.2d 871 (10th Cir. 1960) 20
Tucker v. Calmar S.S. Corp., 457 F.2d 440 (4th Cir. 1972) 19
United States v. United States Gypsum Company, 333 U.S. 364 (1948) 20
Universal Camera Corporation v. N.L.R.B., 340 U.S. 474 (1950) 24
White v. Dunbar, 119 U.S. 47 (1886) 15
White v. Mar-Bel, Inc., 509 F.2d 287 (5th Cir. 1975) 10

STATUTES

28 U.S.C. § 1254(1) 2
28 U.S.C. § 1291 ..... 2, 3
28 U.S.C. § 1338(a) 3
35 U.S.C. § 103 ..... 2, 9
35 U.S.C. § 287 .....2, 9, 22
42 U.S.C. § 1983 19

RULES

Rule 10(b)(5), Federal Rules of Civil Procedure 20
Rule 52(a), Federal Rules of Civil Procedure .....*passim*

TEXTS

Bennett & Davey, DATA TRANSMISSION 4, 14
Carrington, *The Power of District Judges and the Responsibility of Courts of Appeals*, 3 GA. L. REV. 507, 520 (1967) 23
Stern, *Review of Findings of Administrators. Judges, and Juries: A Comparative Analysis*, 58 HARV. L. REV. 70, 80-89 (1944) 24

No. .....

In the Supreme Court of the United States

October Term, 1980

UNITED BUSINESS COMMUNICATIONS, INC.,
a Kansas Corporation,
Petitioner,

vs.

MILGO ELECTRONIC CORPORATION,
a Florida Corporation,
Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE TENTH CIRCUIT

Petitioner respectfully prays that a writ of certiorari issue to review the judgment and opinion of the United States Court of Appeals for the Tenth Circuit in this case.

OPINIONS BELOW

The findings of fact and conclusions of law of the district court relating to the liability issues are reported unofficially at 189 USPQ 160 (D.Kan. 1976). The findings of fact and conclusions of law of the district court relating to the damages issues are reported unofficially at 200 USPQ 481 (D.Kan. 1979). The opinion of the Tenth Circuit Court of Appeals is reported unofficially at 206 USPQ 481 (1980). The above items are reproduced in the Appendix, *infra,* at A1.

JURISDICTION

The appeals court entered judgment on May 29, 1980. A timely petition for rehearing, filed June 26, 1980 was denied by Order of July 22, 1980.

This Court has jurisdiction under 28 U.S.C. § 1254(1).

THE STATUTES AND RULES INVOLVED

35 U.S.C. § 103

35 U.S.C. § 287

28 U.S.C. § 1291

Rule 52(a), Federal Rules of Civil Procedure.

I. United States Code, Title 35, § 103:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

II. United States Code, Title 35, § 287:

> Patentees, and persons making or selling any patented article for or under them, may give notice to the public that the same is patented, either by fixing thereon the word "patent" or the abbreviation "pat.", together with the number of the patent, or when, from the character of the article, this can not be done, by fixing to it, or to the package wherein one or more

of them is contained, a label containing a like notice. In the event of failure so to mark, no damages shall be recovered by the patentee in any action for infringement, except on proof that the infringer was notified of the infringement and continued to infringe thereafter, in which event damages may be recovered only for infringement occurring after such notice. Filing of an action for infringement shall constitute such notice.

III. United States Code, Title 28, § 1291:

The courts of appeals shall have jurisdiction of appeals from all final decisions of the district courts of the United States, the United States District Court for the District of the Canal Zone, the District Court of Guam, and the District Court of the Virgin Islands, except where a direct review may be had in the Supreme Court.

STATEMENT OF THE CASE

This action for patent infringement and for an injunction and damages was brought on July 19, 1971, by respondent Milgo Electronic Corporation in the United States District Court for the District of Kansas. Jurisdiction was founded on 28 U.S.C. § 1338(a). Petitioner seeks review of the decision of the Court of Appeals for the Tenth Circuit which, per curiam:

(1) affirmed as not clearly erroneous the judgment of the district court holding valid and infringed certain claims of the three patents in suit;

(2) affirmed as not clearly erroneous the district court's conclusion of law that a wholly-owned subsidiary of petitioner was, for purposes of determining

infringement and willfulness, the alter ego of petitioner; and

(3) affirmed as not an abuse of discretion the award of treble damages and attorneys' fees as to the different products involved on the ground that the infringement was willful and deliberate.

The patents in suit[1] relate to alleged improvements in modems, devices used to "translate" computer language to a form that can be conveyed and received over telephone wires between computers and computer terminals.

The Whang '023 patent is directed toward a modem design which translates messages by "phase modulation". In particular, the Whang '023 patent claims that its patentability resides in using "eight phase modulation" with a narrow filter bandwidth, measuring 1/T, to translate the computer messages. However, in 1965 before the Whang '023 patent application was filed, a textbook entitled "DATA TRANSMISSION," by Bennett & Davey (DX J-1), was published (App. A161). This textbook taught the use of both of these particular features in modem design. The Patent Office did not consider this textbook when it issued the Whang '023 patent, nor did the district court dispute it. However, the district court found[2] that: (a) the textbook also suggested that better results might be expected if other designs were used, and therefore that the prior art "teaches away from the invention" (Finding 60, App. A89), and (b) the Whang '023 patent claims, though only describing the filter bandwidth as measuring 1/T, should be read as containing additional limitations on the shape of the filter that were not ex-

---

1. 3,524,023, issued August 11, 1970 ("Whang '023"); 3,590,381, issued June 29, 1971 ("Ragsdale '381"); and 3,643,023, issued February 15, 1972 ("Payne '023").

2. These findings were adopted verbatim from findings proposed by respondent.

pressly claimed (Findings 73-76, App. A95-97). The district court then held, without further explanation, the Whang '023 patent represents "significant and non-obvious improvements" over the techniques taught in Bennett & Davey (Findings 60-61, App. A89-90).

The court of appeals, holding that it was "bound by the trial court's findings on obviousness unless they determined to be clearly erroneous" (App. A13), affirmed. Howeevr it neither referred to nor discussed the relation of Bennett & Davey to the claims of the patent, or the district court's conclusion that the patent represented non-obvious improvements over the teachings of the text. It simply referred to the Whang '023 patent as involving "narrow bandwidth filtering", "narrow band limiting" and "extreme band limiting" (App. A14), language which nowhere appears in the claims of the patent.

The Payne '023 and Ragsdale '381 patents were also considered non-obvious by the district court and this finding was affirmed by the court of appeals using the clearly erroneous test of Rule 52(a). These patents, which issued after the Whang '023 patent, deal with improvements of the electrical circuitry of the modems involved.

Two different modems were accused of infringing. Both were manufactured by Rixon II, a wholly-owned subsidiary of petitioner. The DS 4800 modem was found to infringe the Whang '023 patent, the Ragsdale '381 and the Payne '023 patents. The DS 2400 was found only to infringe the Payne '023 patent. The district court entered detailed findings of early knowledge on the part of petitioner of the existence of the Whang '023 patent and copying by Rixon II of a Milgo commercial modem into the DS 4800 modem. From these findings it concluded that infringement was willful and deliberate, justifying treble damages and an award of attorneys' fees. But the

treble damages were not limited to the DS 4800 infringement to which those findings applied. Damages were also trebled as to the DS 2400, which had nothing to do with the Whang '023 patent.

The district court made no findings and cited no evidence from which it could plausibly conclude that there was any copying in the manufacture of the DS 2400 or that the infringement was in any other way willful and deliberate. The court of appeals' opinion makes clear that it did not appreciate the obvious differences in the fact situation with respect to the two different infringing modems. There are no facst on which such an award could have been granted by the district court, or which would support the court of appeals' affirmance, even under the "clearly erroneous" rule. There was simply no appellate review of this issue.

The Tenth Circuit affirmed the trial court's transformation of 327 of petitioner's or Rixon II's leases into Milgo "lost sales". The sole basis for the transformation was Milgo's evidence that for accounting purposes its own leases were treated as "sales". This accounting fiction was not devised for and had no relevance to damages for patent infringement. The leases which petitioner and Rixon II made during the infringement damage periods yielded *gross revenue* of only $60,000. Yet, by treating each lease, without regard to its date of origin, as a *sale* made during the defined damage accounting period, Milgo was awarded *trebled lost profits* of nearly $1,200,000. Rixon II and petitioner made only 62 leases of both accused devices during the infringement accounting periods. This means that the Tenth Circuit affirmed a "lost sale" recovery for 265 leases which were entered into *prior to the accounting period and, in some cases, even prior to issuance of the applicable patent.* The total "lost sale" recovery affirmed by the Tenth Circuit included $850,000

in lost profits for pre-accounting and pre-patent leases. The Tenth Circuit opinion does not address or review this extrastatutory recovery, although it was argued strenuously below.

The trial court determined that the Whang '023 patent was infringed during the period July 19, 1971, through September 30, 1972. The other two patents were found to have been infringed during the period July 28, 1972, through September 30, 1972. However, since petitioner itself was not found to have committed any infringing acts after December 31, 1971, its liability during the period January 1, 1972, through September 30, 1972, rested solely upon the trial court's "Conclusion of Law" (App. A126) that petitioner's wholly-owned corporate subsidiary, Rixon II, the only infringing entity, was "the mere instrumentality, alter ego or agent" of petitioner.[3]

The trial court made 55 detailed "Findings of Fact" relating to this issue. These "Findings of Fact" were never disputed by petitioner. It is clear that the trial court arrived at its "Conclusion of Law" of alter ego (Conclusion 2, App. A126) by applying its concept of the legal principles relating to alter ego to its "Findings of Fact". The court of appeals, however, treating alter ego as a fact issue, refused to consider the soundness of the trial court's legal reasoning. Referring only generally to the trial court's "Findings of Fact" and an assortment of evidentiary facts

---

3. Respondent had originally asserted only that Rixon II was the alter ego of petitioner's co-defendant, United Telecommunications, Inc., because at that time petitioner was marketing Rixon II's modems. The trial court's "Findings of Fact on Issue of United's Use of Rixon II and UBC as Mere Instrumentalities" (App. A109) relate to both United Telecommunications, Inc. and petitioner. These "Findings of Fact" emphasized the corporate independence of Rixon II from both United Telecommunications, Inc. and petitioner. The trial court's "Statement" (App. A109) related solely to explaining its application of legal principles to reach the conclusion that Rixon II was *not* the alter ego of United Telecommunications, Inc.

not mentioned in the trial court's findings, the court of appeals refused to analyze the district court's formulation of the relevant legal standard, or its application of findings thereto, and instead concluded only that the district court's ultimate alter ego determination was not clearly erroneous.

REASONS FOR GRANTING WRIT

I. The Tenth Circuit's opinion on patent validity is in plain conflict with decisions of other circuits, such as *Dual Manufacturing & Engineering, Inc. v. Burris Industries, Inc.*, 619 F.2d 660 (7th Cir. 1980),[4] which hold that a trial court's ruling on obviousness is one of law rather than fact, thus compelling full and independent review by the appellate court. The conflict is likely to proliferate, both in jury and judge tried cases. The importance of patents to the economy requires that there be a uniformly applied standard of review of patent validity, which standard can only be stabilized by this Court. The failure of the Tenth Circuit to exercise review of obviousness as a question of law perpetuates a totally erroneous and legally insupportable interpretation of the Whang '023 patent which can have far reaching consequences not limited to this case.[5]

II. The Tenth Circuit has effectively denied petitioner its statutory right to appellate review of an important legal issue by applying the "clearly erroneous" standard of Rule 52(a) to the district court's alter ego conclusion though that conclusion was reached by applying controlling legal principles to detailed evidentiary findings of historical fact. The Tenth Circuit's application of the

---

4. Petition for Certiorari No. 80-44, filed July 10, 1980.

5. The validity of the Whang '023 and others of the patents in suit is currently in litigation with other parties in the district courts for Delaware (Civil Action No. 78-18) and Massachusetts (Civil Action No. 76-793-S).

"clearly erroneous" standard in this context, although supported by decisions of certain other circuit courts, is in conflict with the decisions of other circuits as well as certain opinions of this Court. This conflict is of long standing and has resulted and will in the future result, if not corrected, in lack of uniformity in the scope of appellate review among the circuits. This Court has recognized its responsibility for defining the proper construction and application of the Federal Rules of Civil Procedure, *Schlagenhauf v. Holder*, 379 U.S. 104, 112 (1964), and has evidenced a particular willingness to exercise the certiorari function to protect the goal of uniformity sought in their enactment. *Hanna v. Plumer*, 380 U.S. 460 (1965).

III. Contrary to the express provisions of 35 U.S.C. § 287, the patentee has been granted infringement damages for "sales" which were lost prior to the start of the infringement accounting period and even prior to issuance of the applicable patent itself. In addition, the court affirmed, without explanation, a conclusion of willful infringement by the DS 2400 modem without any possible evidentiary or factual basis. These results are contrary to statute and the litigant's fundamental entitlement to meaningful appellate review.

I.

The Court of Appeals Improperly Affirmed the District Court's Conclusion of Patent Validity.

A. In Treating Obviousness As a Question of Fact, the Court of Appeals Employed an Improper Standard of Review of Patent Validity.

Based on the analysis of 35 U.S.C. § 103 made by this Court in *Graham v. John Deere Co.*, 383 U.S. 1 (1966), most circuit courts have regarded the question of obvious-

ness as one of law for which full and independent review is required.[6]

Likewise, this Court has consistently followed a practice of independent review of the record to determine as a matter of law whether the correct legal standard has been applied. Thus, in *Anderson's-Black Rock v. Pavement Salvage Co.*, 396 U.S. 57 (1969), after summarizing the preliminary factual inquiries established in *Graham*, the Court stated:

> We conclude further that to those skilled in the art the use of the old elements in combination was

---

6. Sample cases are: Second Circuit: *Koppers Co., Inc. v. S & S Corrugated Paper Machinery Co., Inc.*, 517 F.2d 1182 (2nd Cir. 1975); *Julie Research Laboratories, Inc. v. Guideline Instruments, Inc.*, 501 F.2d 1131 (2nd Cir. 1974). Third Circuit: *Minnesota Mining and Mfg. Co. v. Berwick Industries, Inc.*, 190 USPQ 209, 211 (3rd Cir. 1976). Fourth Circuit: *Deering Milliken Research Corp. v. Beaunit Corp.*, 189 USPQ 565, 567 (4th Cir. 1976); *Blohm & Voss AG v. Prudential - Grace Lines, Inc.*, 489 F.2d 231 (4th Cir. 1973), *cert. denied*, 419 U.S. 840 (1974). Fifth Circuit: *Parker v. Motorola, Inc.*, 524 F.2d 518 (5th Cir. 1975); *White v. Mar-Bel, Inc.*, 509 F.2d 287 (5th Cir. 1975); *Garrett Corp. v. American Safety Flight Systems, Inc.*, 502 F.2d 9 (5th Cir. 1974). Sixth Circuit: *Dickstein v. Seventy Corp.*, 522 F.2d 1294 (6th Cir. 1975); *Philips Industries, Inc. v. State Stove & Mfg. Co., Inc.*, 522 F.2d 1137 (6th Cir. 1975); *Schnadig Corp. v. Gaines Mfg. Co., Inc.*, 494 F.2d 383 (6th Cir. 1974) (mixed question of law and fact); *Shatterproof Glass Corp. v. Guardian Glass Co.*, 462 F.2d 1115 (6th Cir. 1972), *cert. denied*, 409 U.S. 1039 (1972). Seventh Circuit: *Dual Manufacturing and Engineering, Inc. v. Burris Industries, Inc.* 619 F.2d 660 (7th Cir. 1980); *Pederson v. Stewart-Warner Corp.*, 536 F.2d 1179 (7th Cir. 1976), cert. denied 429 U.S. 985; *E-T Industries, Inc. v. Whittaker Corp.*, 523 F.2d 636 (7th Cir. 1975); *Chicago Rawhide Mfg. Co. v. Crane Packing Co.*, 523 F.2d 452 (7th Cir. 1975); *Gettelman Mfg., Inc. v. Lawn 'N' Sport Power Mower Sales & Service, Inc.*, 517 F.2d 1194 (7th Cir. 1975); *Erie Technological Products, Inc. v. Die Craft Metal Products, Inc.*, 461 F.2d 5 (7th Cir. 1972); *Armour & Co. v. Wilson & Co.*, 274 F.2d 143 (7th Cir. 1960). Eighth Circuit: *Hadfield v. Ryan Equipment Co.*, 456 F.2d 1218 (8th Cir. 1972); *Flour City Architectural Metals v. Alpana Aluminum Products, Inc.*, 454 F.2d 98 (8th Cir. 1973); *Airlite Plastics Co. v. Plastilite Corp.*, 526 F.2d 1078 (8th Cir. 1975), *cert. denied*, 96 S.Ct. 1672 (1976). Ninth Circuit: *Payne Metal Enterprises, Ltd. v. McPhee*, 382 F.2d 541 (9th Cir. 1967).

not an invention by the obvious - nonobvious standard. 396 U.S. at pp. 62, 63.

In *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273 (1976), this Court again reviewed the issue of patentable invention. Holding that "the ultimate test of patent validity is one of law" (425 U.S. at 279-80), the Court made an "independent examination of the evidence" (425 U.S. at 280) and concluded that the patent in suit was invalid because it was "not patentable under standards appropriate for a combination patent." *Id.* at 282.

In this case the Tenth Circuit clearly demonstrated that it has no clear understanding of its duty of judicial review, particularly in patent cases. While it pays lip service to *Graham*, it is apparent from a reading of the opinion that the court of appeals regarded the determination of obviousness as a question of fact reviewable only under the "clearly erroneous" test.

> Obviousness requires factual determinations which are entitled to the usual respect accorded determinations of fact, and, as such, an Appellate Court is bound by the Trial Court's findings on obviousness unless they are determined to be clearly erroneous. *Rutter v. Williams*, 541 F.2d 878 (10th Cir. 1976); *CMI Corporation v. Metropolitan Enterprises, Inc.*, *supra*. We are not a trial court and a case such as the one at bar cannot be tried *de novo* on appeal.[7]

Any question about the intentions of the Tenth Circuit in this case is dispelled by its later decision in *Norfin, Inc. v. International Business Machines Corporation*, No.

---

7. The citation of *Rutter v. Williams* is perplexing, since the case plainly holds that "We are not bound by [the trial court's] conclusions of law that the Rutter device was not obvious to one skilled in the art." *Id.*, at 881. Not only is the appellee court apparently in conflict with this Court and other circuit courts, but even with its own previous decisions.

78-1620 (10th Cir., filed July 7, 1980), where Judge Barrett, who sat on the panel in this case, writes:

> IBM contends that the question of obviousness was improperly submitted to the jury and "that in this Circuit . . . as in all other circuits . . . obviousness is a question of law for a court's ultimate determination." [Appellant's Br. at p. 46]. We disagree.
>
> > Whereas the ultimate question of patent validity is, of course, one of law, Moore v. Schultz, 491 F.2d 294 (10th Cir. 1974); Hinde v. Hot Sulphur Springs, Colorado, 482 F.2d 829 (10th Cir. 1973), obviousness has always been considered a question of fact. Sidewinder Marine, Inc. v. Starbuck Custom Boats and Products, Inc., supra, See also: John Zink Company v. National Airfoil Burner Company, 613 F.2d 547 (5th Cir., 1980); Control Components, Inc. v. Val Tek, Inc., 609 F.2d 763 (5th Cir. 1980).

Id., Slip op. at 17, 18. Judge Barrett then quoted the language from the opinion of the Tenth Circuit in this case holding that the issue of obviousness is subject to the "clearly erroneous" standard of review (App. A13).

The Tenth Circuit has in this case operated under a misunderstanding of the standards of review for patentability, and that misunderstanding has been extended in *Norfin, supra.* Unless this Court grants certiorari and reverses, there will be a clear disparity between the Tenth Circuit and other circuits. This is not only unfair to litigants, it manifestly invites undesirable forum shopping, which inevitably occurs when one circuit is perceived to have departed materially from a uniform application of an important principle of law.

B. The Claimed Subject Matter of the Whang '023 Patent Should Have Been Found Obvious in the Light of the Prior Art As a Whole.

Failure of the appellate court to carefully and independently review all of the prior art cited against the patents in suit in accordance with such decisions of this Court as *Graham, Sakraida,* and *Anderson's Black Rock, supra,* has resulted in a total miscarriage of justice. This is most readily apparent in the case of the Whang '023 patent.

Of all the claims in the Whang '023 patent, only nine were in suit (described in Findings 41-45, App. A77-79). These nine claims include as an element an electrical filter means described in terms of having a bandwidth equal to the 1/T. T is the elapsed time interval of one modulation period. None of the patent claims in suit define the bandwidth of the filter as being limited to 1000 Hertz (Hz).[8]

The court of appeals made no reference in its opinion to these claims. The court's description of the invention is instead couched in terms of the characteristics of the modems actually marketed by Milgo. The opinion simply points out that:

> Whang '023's utilization of differential eight phase modulation of a single carrier and narrow bandwidth filtering was contrary to the prior art; that Whang was the first to employ narrow band limiting in a phase modulated system; that modems incorporating the Whang '023 were the first commercially acceptable modems capable of transmitting 2400 bps over ordinary switched voice-grade telephone lines; that prior to the Whang '023 the modem industry felt the best results

---

8. One Hz equals one cycle per second.

> could be achieved by modems incorporating wide band energy spectrum and two or four level modulation; that Whang approached the problem with a completely opposite philosophy and was the first to combine eight level modulation and extreme band limiting into one modem. (App. A14)

The opinion below overlooks the fact that the Whang '023 patent claims in suit do not define and are not limited to a modem having a restricted bandwidth of 1000 Hz. All of the claims describe the bandwidth restricting filter by the definition 1/T. For a 4800 bps modem using eight phase modulation 1/T equals 1600 Hz, not 1000 Hz. The court has thus measured patentability by considering the invention to be something other than what is claimed, which is directly contrary to this Court's admonition that a critical factor in determining "obviousness" is that "differences between the prior art and the *claims at issue* are to be ascertained." *Graham v. John Deere Co., supra* (emphasis supplied).

The Bennett & Davey text (DX J-1) discloses differential eight phase modulation on a single frequency carrier (App. A167-68) and restriction of the bandwidth to 1/T (App. A169-70). The trial court's findings reflect a recognition of this, but differentiate technically the claim language from the prior art disclosure by adding a further limitation which defines the filter as having a sharper cut-off than what is achieved with what is termed a 100% roll-off (Findings 73-76, App. A95-97).[9] This effort by the trial court to avoid the applicability of the prior art by adding limitations in the claims, affirmed without explanation by the Tenth Circuit, is directly contrary to decisions of this Court.

---

9. Yet, the Bennett & Davey text and drawings at pp. 225-26 (App. A169-70) clearly disclose sharp cut-off filtering, showing 50% roll-off and zero roll-off (rectangular shaping).

Patent claims may not be treated "like a nose of wax which may be turned and twisted in any direction, by merely referring to the specification, so as to make it include something more than, or something different from, what its words express." *White v. Dunbar*, 119 U.S. 47, 51-52 (1886). The scope of protection granted by a patent is defined by the language of its claims, and it is the "claims which define the boundaries of a patent monopoly." *Great Atlantic & Pacific Tea Co. v. Supermarket Equip. Corp.*, 340 U.S. 147, 149 (1950). It is the claims and only the claims which "measure the invention." *General Electric Co. v. Wabash Appliance Corp.*, 304 U.S. 364, 369 (1938).

All of the claims define the filter means as having a bandwidth of 1/T, and nothing more is said as to roll-off characteristics or other features of the filter means. The claims should have been held invalid, and may not be validated by reading critical elements into them, as the trial court's findings and appellate court's affirmance do.

II.

Certiorari Is Required to Assure Uniform Application of Rule 52(a) in an Area in Which It Has Been Applied Inconsistently Within and Between the Courts of Appeal.

The circuit courts of appeal have been without clear Supreme Court guidance in their efforts to decide whether, and under what circumstances, district court determinations should be subject to the "clearly erroneous" standard of the review of Rule 52(a). Repeatedly, and in a variety of legal and factual contexts, the district courts apply historical facts, as found on the basis of an evidentiary record, to a predetermined legal standard of conduct, in order to determine the legal significance of the facts as found. The courts of appeal have failed to formulate a

general rule to guide their review of such determinations, perhaps because of conflicting language in previous opinions of this Court.[10] They have therefore applied Rule 52(a) inconsistently, not only between the various circuits, but within particular circuits as well, as a result of which many litigants, like petitioner below, are denied their right to independent review at the circuit level of what are actually legal conclusions reached by the district court.

The instant case provides this Court with an opportunity to provide the courts of appeal with a standard by which to determine which district court conclusions, "drawn from the whole mass of evidence", are not within the ambit of Rule 52(a), and which decisions "must be based ultimately on the application of the fact-finding tribunal's experience with the mainsprings of human conduct", and are therefore to be reviewed under the "clearly erroneous" standard.

---

10. Both in *Commissioner v. Duberstein*, 363 U.S. 278 (1960), and in *Baumgartner v. United States*, 322 U.S. 665 (1943), the issue reviewed involved the ascertainment of the motive or intent behind an individual's actions on the basis of the circumstances under which he acted. However, the two cases arrived at irreconcilable results, and employed inconsistent language to explain them. The *Baumgartner* Court stated that:

> [a] "finding of fact" may be the ultimate judgment on a mass of details involving not merely an assessment of the trustworthiness of witnesses but other appropriate inferences that may be drawn from living testimony which elude print. . . . Finding so-called ultimate "facts" more clearly implies the application of standards of law. . . . Thus, the conclusion that may appropriately be drawn from the whole mass of evidence is not always the ascertainment of the kind of "fact" that precludes consideration by this Court.

Id. at 670-71. Conversely, in *Duberstein* it was held that:

> [d]ecision of the issue presented in these cases must be based ultimately on the application of the fact-finding tribunal's experience with the mainsprings of human conduct to a totality of the facts of each case.

Id. at 289.

Most of the $2,340,726.23 judgment below was assessed against petitioner on the basis of the district court's determination that Rixon II, a subsidiary of petitioner and the entity found to have actively infringed the patents in question during that period, was "the mere instrumentality, alter ego or agent" of petitioner, during the period of January 1, 1972, through September 30, 1972. That determination, which the district court styled a "Conclusion of Law", was based solely upon the court's application of a predetermined legal standard to detailed, subsidiary "Findings of Fact" made by the court on the basis of a voluminous evidentiary record. Petitioner has not, and does not now challenge those specific findings.

In the court of appeals, petitioner argued that the findings of the district court showed positively the absence of the elements identified in *Quarles v. Fuqua Industries, Inc.*, 504 F.2d 1358 (10th Cir. 1974); *Kilpatrick Bros., Inc. v. Poynter*, 473 P.2d 33 (Kan. 1970); and *Dixon v. Process Corp.*, 382 A.2d 893 (Md. App. 1978), as essential to a conclusion that one corporation is the mere instrumentality of another. Respondent did not assert on appeal that the district court's alter ego "Conclusion" was a finding of fact, subject to Rule 52(a), but rather, argued that the facts as found by the district court fit within the legal doctrine announced in *Quarles* and *Kilpatrick* and cases from other jurisdictions cited by respondent. Nevertheless, after making a random selection of evidence which was not included in the district court's detailed written findings, and which the court of appeals felt "tended" to support, but did not "compel", the alter ego "Conclusion", the court of appeals decided that it had no alternative but to affirm on the basis of the "clearly erroneous" rule. The court of appeals refused to consider whether the district court had correctly formulated the relevant legal principles and properly applied them to its subsidiary fact

findings. Had the court of appeals independently reviewed the district court alter ego determination it would have been compelled to reverse. Each of the fact findings on the issue, when applied correctly to the proper legal standard, point to the absence of an alter ego relationship between petitioner and Rixon II.

The court of appeals' misapplication of the "clearly erroneous" rule to the district court's alter ego conclusion is but an example of the confusion that exists regarding the proper application of Rule 52(a) to district court determinations that are made by measuring evidentiary facts against a predetermined legal standard.

Without explanation, and without considering that an ultimate alter ego determination requires the trial court to formulate a legal standard of conduct, and to apply subsidiary facts thereto, various courts of appeal have concluded that a district court's determination that one corporation is the alter ego of another is a finding of fact. *See, e.g., DeWitt Truck Brokers, Inc. v. W. Ray Flemming Fruit Company,* 540 F.2d 681 (4th Cir. 1976); *G.M. Leasing Corp. v. United States,* 514 F.2d 935 (10th Cir. 1975); *National Bond Finance Company v. General Motors Corporation,* 341 F.2d 1022 (8th Cir. 1965). However, many courts, without reference to Rule 52(a), have adopted the view that such determinations are conclusions of law, and have thus undertaken detailed independent review thereof. *See e.g., Bendix Home Systems, Inc. v. Hurston Enterprises, Inc.,* 566 F.2d 1039 (5th Cir. 1978); *Edwin K. Williams & Co. v. Edwin K. Williams & Co. - East,* 542 F.2d 1053 (9th Cir. 1976); *Berger v. Columbia Broadcasting System, Inc.,* 453 F.2d 991 (5th Cir. 1972); *Hollander v. Henry,* 186 F.2d 582 (2nd Cir. 1951). Further, the Third Circuit, when asked to review a district court alter ego determination which was disguised within a tax code question, held that it is "well settled" that the tax court's "ultimate finding of

fact, which represents an inference drawn from the basic facts . . . is reviewable as an issue of law and is not subject to the clearly erroneous rule". *Joseph Lupowitz Sons, Inc. v. C.I.R.*, 497 F.2d 862, 865 (3rd Cir. 1974).

The analysis undertaken in *Lupowitz* was exactly the same as the one by which every alter ego determination must be made. Many of the factors identified in *Lupowitz* were similar or identical to those factors enumerated in *Fish v. East*, 114 F.2d 177 (10th Cir. 1940), quoted in the opinion of the Tenth Circuit below, and considered by the district court in making its alter ego determination. However, due to the confusion extant in the courts of appeal as to the proper application of Rule 52(a), a different standard of review was employed in *Lupowitz*, simply because the alter ego issue there was disguised by the tax ramifications of its determination.

Rule 52(a) has been applied inconsistently in other contexts involving review of district court determinations based on the application of evidentiary or historical facts to a predetermined legal standard.[11] As a result of this

---

11. *Compare Miller v. U.S.*, 587 F.2d 991 (9th Cir. 1978); *O'Neill v. United States*, 450 F.2d 1012 (3rd Cir. 1971); *Tucker v. Calmer S.S. Corp.*, 457 F.2d 440, 444 (4th Cir. 1972) *with*, *Mamiye Brothers v. Barber Steamship Lines, Inc.*, 360 F.2d 774 776 (2nd Cir. 1966); *Nolan v. Sullivan*, 372 F.2d 776, 778 (3rd Cir. 1967); *Hicks v. United States*, 368 F.2d 626 (4th Cir. 1966). Each of these cases considered the standard of review to be applied to the trial court's ultimate determination on the issue of negligence, and arrived at different conclusions not only between, but within circuits. Similarly, in *Glasson v. City of Louisville*, 518 F.2d 899 (6th Cir. 1975), an action against local police officers under 42 U.S.C. § 1983, it was held that the district court's determination that the defendant had acted in good faith and upon reasonable grounds was subject to independent review in the court of appeals, while in *Famous Knitwear Corp. v. Drug Fair, Inc.*, 493 F.2d 251, 252 (4th Cir. 1974), it was held that the reasonableness of third-party reliance on manifestations of apparent authority by principal and agent is an "ultimate inference of fact" subject to the clearly erroneous rule. In *S.E.C. v. Texas Gulf Sulphur Co.*, 401 F.2d 833, 849, n. 11 (2nd Cir. 1968),

(Continued on following page)

inconsistent application, the purpose of the Federal Rules to provide uniformity of procedure in the federal courts has been frustrated in a very critical area.

"Calling a judge's legal conclusion a finding of fact is an all too easy way for appellate judges to obscure or even avoid legal issues when the result of the trial suits them." *Ruby v. American Airlines, Inc.*, 329 F.2d 11 (2nd Cir. 1964), Friendly, J. dissenting. The purpose of Rule 52(a) is to delegate primary responsibility to the district courts for determinations that are made by exercising those functions which are particularly within the province of the trial court as the tribunal which has had the first-hand opportunity to receive evidence. *United States v. United States Gypsum Company*, 333 U.S. 364, 395 (1948) (Rule 52(a) was enacted to adopt the prior equity practice under which "the findings of the trial court, when dependent upon oral testimony where the candor and credibility of the witnesses would best be judged, had great weight with the appellate court"). Where the trial court makes detailed findings of historical fact based upon a voluminous

---

Footnote continued—

it was held that the district court's determination of the "materiality" of information disclosed or withheld in the context of a Rule 10b(5) prosecution is a finding of ultimate fact not subject to the "clearly erroneous" rule, while in *Steinbrugge v. Haddock*, 281 F.2d 871 (10th Cir. 1960), an action to rescind a real estate sales contract, in which it was held that the broker had acted as the agent of both the buyer and the seller, the Tenth Circuit refused to make an independent review of the trial court's conclusion that the agent had made full, fair and complete disclosure to the plaintiff-buyer. Likewise, in *Gamble v. C.I.R.*, 242 F.2d 586 (5th Cir. 1957), the determination of whether the taxpayer had held certain property for sale to customers in the ordinary course of business was held to be an ultimate finding of fact subject to independent review, while in *Fall River Gas Appliance Co. v. C.I.R.*, 349 F.2d 515 (1st Cir. 1965), the Tax Court's determination of whether a purchase constituted a business expenditure or a capital expense was held to be a finding of fact to be reversed only if clearly erroneous, even though in both cases the trial court had made its determination by applying evidentiary facts to a list of relevant factors enumerated in prior decisions and regulations.

evidentiary record, formulates a legal standard on the basis of prior decisions, and makes an ultimate determination by applying those facts to that standard, the purpose of Rule 52(a) cannot be fulfilled by reviewing that determination only to assure that it is not clearly erroneous.

The determination of whether one corporation is the alter ego of another does not involve the simple sorting of disputed evidence and finding of historical facts. Rather, it involves an analysis of the findings of historical facts, a determination of the relative weight to attach to the respective findings, the formulation of a legal standard in accordance with prior case law, a measurement of the relevant findings against that previously enunciated legal standard, and a decision as to what legal significance will flow therefrom. Thus, the determination does not call upon the trial court to exercise those functions to which its proximity to the trial particularly suit it. But, rather, it requires the court to make various legal conclusions, the ultimate responsibility for which has been delegated in the federal system to the circuit courts of appeal. Especially where, as here, the litigants do not contest the evidentiary findings upon which the district court's ultimate determination is made, the appellate court is in as good a position as the trial judge to answer the ultimate alter ego question, and should therefore undertake an independent review of the trial court's resolution thereof. *E.F. Drew Co. v. Reinhard,* 170 F.2d 679, 684 (2nd Cir. 1948).

The Supreme Court should provide guidance to the courts of appeal to assure uniform application of Rule 52(a) by holding that, since the district court alter ego determination was made by measuring evidentiary facts against a predetermined legal standard, the court of appeals erred in subjecting it to the "clearly erroneous" standard of re-

view of Rule 52(a). By doing so, it can guarantee litigants in a broad variety of federal cases their right to independent appellate review of what are actually legal determinations by the district courts.

III.

Certiorari Is Required to Protect the Integrity of 35 U.S.C. § 287 and to Assure Meaningful Appellate Review.

The court of appeals' affirmance creates a haunting precedent. First, the affirmance rewrites 28 U.S.C. § 287 by broadening a patentee's right to infringement damages to include "lost sale" damages for leases ("sales") made prior to the accounting period and prior to the issuance of the applicable patent. The statute limits a patentee's right to infringement damages to a defined accounting period. The Tenth Circuit affirmed the award of over $850,000 in "lost sale" damages for pre-accounting and even pre-patent period transactions.[12] Second, the affirmance of willful infringement by the DS 2400 modem, based exclusively on willful infringement evidence concerning the DS 4800 bps modem provides authority for the proposition that a patentee may make its willfulness case on one device and thereby obtain a finding of willfulness on another device for which it has offered absolutely no evidence.

The Tenth Circuit's opinion is absolutely devoid of any reference to or consideration of evidence concerning willful infringement by the DS 2400. The only discussion of willfulness relates exclusively to evidence of willful infringement of the Whang '023 patent by the DS 4800

---

12. The prejudgment interest on these pre-accounting period transactions amounts to over $300,000 in additional damages.

modem. Yet the DS 2400 was *never* charged to infringe the Whang '023 or the Ragsdale '381 patents.

Although it is submitted that if the court of appeals had correctly reviewed the petitioner's claims as to these two issues on appeal, the court would have reversed the lower court's conclusions, it is further submitted that the court never reached the threshold of deciding these questions. That the court failed to review these conclusions is manifest in the simple fact that its opinion does not address petitioner's claims. Had it done so, it would have concluded that it was logically and legally impossible to affirm the trial court.

Since the court of appeals "serves and acts, rather and only, in the capacity of a reviewing court", *Raulie v. United States,* 400 F.2d 487, 509 (10th Cir. 1968), an appellate court cannot fulfill its responsibility to the system and the litigants if it fails to provide meaningful review.[13] As Professor Carrington has described the reviewing process:

> The reviewing court must . . . examine the record closely enough to assure that the law is not being flouted. Furthermore, some marginal check on the "unfairness and unskillfulness" of the judge in conducting the trial ought to be supplied, in the interest of the litigants, and in the public interest in providing them with reasonable satisfaction in the process.

Carrington, *The Power of District Judge, and the Responsibility of Courts of Appeals,* 3 GA. L. REV. 507, 520 (1969).

---

13. The court in *Empire Life Insurance Co. of America v. Valdak Corporation,* 468 F.2d 330 (5th Cir. 1972), recognized the magnitude of this obligation when it proclaimed:

> Appellate review does not consist of supine submission to erroneous legal concepts . . . Our duty is to enunciate the law on the record facts. Neither the parties nor the trial judge, by agreement or passivity, can force us to abdicate our appellate responsibility.

Id. at 334.

In the present case, the court of appeals failed to provide even this "marginal check". This case is not one involving mere factual issues of no moment to anyone save the litigants, *Rudolph v. U.S.*, 370 U.S. 269 (1962), nor is it a request promoting judicial activism or broadening of appellate review. Rather, this petition seeks the Court's assistance in resolving the question of whether the courts of appeal are to assume and fulfill their responsibility to review or whether the appellate court may effectively eliminate the appellate process by simply ignoring issues which are central to the litigants' case.[13]

---

13. The Court faced a similar issue when it granted certiorari in *Universal Camera Corporation v. N.L.R.B.*, 340 U.S. 474 (1951), to consider the duty of the courts of appeal to review administrative findings and conclusions under the substantial evidence standard, a standard of review which involves even less scrutiny than the "clearly erroneous" standard. *See* Stern, *Review of Findings of Administrators. Judges, and Juries: A Comparative Analysis*, 58 HARV. L. REV. 70, 80-89 (1944). In this regard the Court recognized that the courts of appeal were not fulfilling their responsibility to afford litigants their fundamental entitlement to review:

> We conclude . . . that courts must now assume more responsibility for the reasonableness and fairness of Labor Board decisions than some courts have shown in the past. Reviewing courts must be influenced by a feeling that they are not to abdicate the conventional judicial function. Congress has imposed on them responsibility for assuring that the Board keeps within reasonable grounds.

340 U.S. 474, 490 (1951).

CONCLUSION

For the foregoing reasons, petitioner respectfully requests that a Writ of Certiorari issue to review the judgment of the Court of Appeals for the Tenth Circuit.

Respectfully submitted,

WILLIAM H. CURTIS
(Counsel of Record)
1700 Bryant Building
Kansas City, Missouri 64106
(816 842-5910)

CARTER H. KOKJER
800 Ozark National Life Building
Kansas City, Missouri 64106
(816 474-5300)

JOHN F. DODD
2330 Johnson Drive
Shawnee Mission, Kansas 66205
(913 676-3000)

Attorneys for Petitioner, United Business Communications, Inc.

Of Counsel:

MORRISON, HECKER, CURTIS, KUDER & PARRISH
LOWE, KOKJER, KIRCHER, WHARTON & BOWMAN

APPENDIX

UNITED STATES COURT OF APPEALS
TENTH CIRCUIT

No. 78-1624

MILGO ELECTRONIC CORPORATION,
a Florida Corporation,
Plaintiff-Appellee,

v.

UNITED BUSINESS COMMUNICATIONS, INC.,
a Kansas Corporation,
Defendant-Appellant.

Appeal from the United States District Court
For the District of Kansas
(D.C. No. KC 3380)

(Filed May 29, 1980)

Stanley R. Jones (Harold L. Jackson with him on the brief), of Jackson, Jones & Price, Tustin, California; (J. Donald Lysaught of Weeks, Thomas, Lysaught, Bingham & Mustain, Overland Park, Kansas, with him on the brief) for Plaintiff-Appellee.

William H. Curtis (Michael C. Manning with him on the brief), of Morrison, Hecker, Curtis, Kuder & Parrish, Kansas City, Missouri; Carter H. Kokjer of Lowe, Kokjer, Kircher, Wharton & Bowman, Kansas City, Missouri; (John F. Dodd, Shawnee Mission, Kansas; and Robert D. Benham of McAnany, Van Cleave & Phillips, Kansas City, Kansas, with them on the brief) for Defendant-Appellant.

Before BARRETT, DOYLE and LOGAN, Circuit Judges.

PER CURIAM.

United Business Communications, Inc. (UBC) appeals from an adverse judgment in a patent infringement action initiated by Milgo Electronics Corporation (Milgo). Bifurcated trials to the Court on the issues of liability and damages were held in September 1975 and December 1977, respectively, after which the Court found, *inter alia*, that: Each of the Milgo patents in question were valid; certain claims of each patent were infringed by the manufacture, use and sale of the accused modems; Rixon II was a mere instrumentality, alter ego, or agency of UBC; the infringement was flagrant and willful; and Milgo was entitled to a total judgment, including taxable costs, of $2,340,726.23.

Concurrent with its judgment upholding the validity of the Milgo patents and awarding damages, the Court rendered detailed findings of fact and conclusions of law encompassing in excess of one hundred pages of the record on appeal. We will therefore limit our development of the factual background to those issues we deem dispositive on appeal, i.e., the validity of the patents in question, the existence of an agency relationship between UBC and Rixon II; and the damages awarded.

I.

Patent Validity

Milgo is a Florida corporation engaged in the manufacture and sale of data communication equipment, including "modems", which are used to implement communication of binary data over telephone lines. It is not possible to transmit digital information by applying it directly

to the telephone lines; accordingly, modems were developed for converting digital information from its original form to a form in which it can be carried on telephone lines. Simply stated, a modem is a telephone made specifically for a computer or an information terminal to communicate with another computer or terminal over an ordinary telephone line. Modems convert output signals from a computer or terminal into electric signals suitable for transmission through a telephone line; and convert the received signal back into an information signal receivable and understood by a computer or terminal. This process of signal conversion is called *mod*ulation (sending) and *dem*odulation (receiving) and the word modem is a contraction of *mod*ulator-*dem*odulator.

Computers operate on a number system in which all numbers are represented by an array of "1's" and "0's", known as the binary numbering system. In systems for the transmission of data, the speed of transmission is usually defined in "bits" ("1" or "0") per second or "bps".

Telephone lines designed for voice communication have a bandwidth of approximately 300 to 3000 Hertz (Hz).[1] Such lines are classified as either "switched or dial up lines" or "leased lines". Switched or dial up lines utilize multiple pairs of lines and diverse electronic equipment which are switched together in a random, first available basis to form a complete circuit each time a telephone call is placed. Leased lines, on the other hand, are not switched randomly with every call and such lines can therefore be specially treated or conditioned to make them more readily adaptable for data transmission. Leased lines are graded as Types 4, 4-A, 4-B, and 4-C and the cost of such lines increase in that order. Switched or dial up lines are more difficult to utilize for data transmission

1. One Hz equals one cycle per second.

than leased lines, and the less expensive leased lines, *e.g.* Types 4 and 4-A are more difficult to utilize than the very expensive, highly conditioned Type 4-C leased lines.

By the early 1960's high speed computers had surpassed the ability of the available modems to transmit data over ordinary switched telephone lines. Typical available modems used a two or four level modulation technique to represent data on the carrier. Proponents of the two level modulation technique felt it was preferable over the four level because the error rate was believed to be directly related to the number of levels. It was also believed that if the bandwidth of the signal was narrowed, the data rate had to be reduced accordingly. The four level modulation technique, on the other hand, required a wide energy spectrum, from 600 to 3000 Hz, which was considered "necessary to permit the recovery of a clock signal and provide a high signal to noise ratio". As such, the four level modulation technique incorporating a wide energy spectrum required the utilization of expensive, highly conditioned leased lines.

In the late 1950's and early 1960's, after its own research and development group could not produce an adequate modem for the new computers, Western Union began looking for a modem which would allow its customers to connect their high speed computers to its newly constructed broadband exchange (BEX) which operated much like its switched telephone network.

Western Union specifically sought a modem which would operate satisfactorily at 2400 bps using less than a 1000 Hz bandwidth, since it had concluded that such a modem would work within its BEX network. Western Union's own personnel, however, were skeptical that such a modem could be developed, inasmuch as it was generally believed that the utilization of a narrow band, such as 1000

Hz, would decrease the signal to noise ratio and that the error rate would be substantially increased.

In early 1965 Sang Whang, and several other Milgo employees, took part of Milgo's missile tracking system that handled data as a stand-alone modem and met with Western Union's personnel. Western Union, however, believed Milgo's modem was entirely inadequate, and it reiterated what it considered to be a workable modem for its BEX network.

Upon his return to Milgo, Whang proceeded to develop a modem capable of functioning within the prescribed limitation of Western Union's BEX network. In so doing, Whang developed a modem which, for 2400 bps operation, utilized eight level modulation within a narrow bandwidth centered at 1700 Hz. Whang's prototype modem created considerable interest at Western Union:

> Q. What was the substance of that phone call? A. Well, the phone call was to Mr. Boughtwood and he came out of his office laughing, as I recall. He had gotten a phone call from Sang Whang, I believe, of Milgo, and Sang had informed him that unfortunately they could not build a modem that such a thousand cycles of bandwidth and he was very sorry about that, Mr. Whang was, but however would we be amenable to coming and looking at one that used eight hundred cycles of bandwidth, and it tickled us considerably but that was the first contact through any of this. I think it took us about twenty minutes to get our airline tickets.
>
> Q. I take it you were interested in seeing an eight hundred cycle bandwidth modem? A. We were not believers at that moment.
>
> Q. You didn't believe they had done that? A. No.

Q. Did Sang Whang do it? A. He sure did.

Q. Would you set forth those key features that it highlighted? A. Okay. By far the most unique feature to us at that point in time was the narrow bandwidth that it required to operate. The second one was the compression technique used to get that narrow band. It was essentially the eight-phase modulation, because this was the first time that we had ever seen or heard of anybody making a practical version of an eight-phase modem. Four phases was considered the state of the art at that point in time.

Q. What do you mean by state of the art? A. The state of the art is pushing the art. It's the latest version, it's the latest technology, the latest technique, and we had gone through a development phase spearheaded by the Bell System to get to the four-phase modem and they had developed that and refined it and that was considered the state of the art in 1965 and this was a breakthrough, both in the narrow band and in the fact that they were using eight phases.

* * *

Q. And you figured the Milgo modem was a breakthrough at that point? A. To us it certainly represented a breakthrough at that point in time, yes. It satisfied a real need that we had, satisfied all our requirements.

[R. Appdx., Vol. I at pp. 282-284].

Whang subsequently was issued a patent for his modem, U.S. Patent No. 3,524,023 (Whang '023). The Whang '023 patent disclosed and claimed a high speed data modem system intended to operate over ordinary unconditioned switched telephone lines which would function in

ordinary lines without a variable equalizer. The patent asserted that the elimination of the equalizer was achieved by limiting the bandwidth of the data transmission channel to substantially less than the 300-3000 Hz bandwidth available in the line; that a composite band limiting filter restricted the band in the modem to a width of less than 1000 Hz for a 2400 bps data rate, and that the band is centered on a frequency of around 1700 Hz with a low side of 1200 Hz and a high side of 2200 Hz. The patent asserts that the band binding of the signal to the narrow band of less than 1000 Hz resulted from Whang's discovery that within this bandwidth, the transmission characteristics of all ordinary telephone lines in a switched network will "look" substantially alike and behave the same.

Whang's '023 patent, which was assigned to Milgo, was expanded upon and improved by U.S. Patent No. 3,-590,381 (Ragsdale '381) and U.S. Patent No. 3,643,023 (Payne '023) which improved the detection techniques by relating data representing phase angles in a squared intermediate frequency at center sampling times to digital counts in high speed binary counter. These patents are follow-on patents to the Whang '023 resulting from work done by other Milgo employees. With these patents, the analog detection circuits of the first Milgo Modem 4400/24 were replaced by digital detectors, thereby overcoming the repeatability problems associated with analog detectors.

Milgo's patented modems were successfully marketed from the outset. Western Union successfully utilized the Milgo 2400 bps on its BEX, and the Milgo 4800 modem Model 4400/48, derived by applying the principles of a 2400 bps modem to a 4800 bps modem, was considered an "immediate commercial success", when introduced in early 1968.

During mid 1968 Rixon,[2] a modem manufacturer, marketing the PM24 modem which required conditioned lines and the Sebit 24 modem which was a two level amplitude modulated vestigial sideband device, arranged to test one of Milgo's Model 4400/48 modems at one of Milgo's customer's locations. This test was made on a weekend without Milgo's consent. After determining that the Milgo modem functioned efficiently, Rixon obtained a Milgo modem and embarked on a copying process, which extended over a two year period. Howard R. Andrews, a Rixon employee, deposed:

> Q. Did you receive instructions from Gatfield to copy point to point the various circuit cards in the Milgo modem? A. Not precisely. At the time I was assigned to the program, the modem had been in the plant for approximately a week at least, I say at least, because it could have been sitting there for a month I suppose. But people had actively been working on it for a week according to what they told me. They had a team of technicians, not engineer actually doing the point by point analysis.
>
> They would take the printed circuit cards, a very large piece of paper, put it up on the wall of this room, drawing the connections, label the I.C. packs with certain numbers and trace out the tracks on the board. So the actual point to point wiring was traced out by technicians. The task I was assigned to after I had been reassigned by Mr. Hollis to Mr. Gatfield was the job of interpreting these schematics and putting them into a form that is really understandable.
>
> In other words, a schematic like this. If it were jumbled around in the fashion that it would be taken

2. Rixon's relationship with UBC is discussed, *infra*, in II.

off a P.C. board, it would be incomprehensible. It requires a certain regularity of layout of the components and the connections for you to understand what it means.

That was the task I and a couple of other engineers were given. One engineer who worked for me, Mr. Ditman, came over with me from the engineering group as part of this task force.

The two of us together did I would say 95 percent of the interpretation and the redrawing of the schematics made by the technicians.

* * *

Q. You mentioned that you wrote a report along with the schematics. A. It was not formal. It was handwritten. It was not typed because this whole program was handled with great secrecy. Only certain people were allowed to know what went on. You had to carefully identify yourself to people in the locked room before you would be admitted. We were all sworn never to tell anybody where this model, what it was, where it came from and how Rixon acquired it, although I did find that out and things of this nature.

So because of this veil of secrecy, secretaries were not certainly supposed to be typing up reports. Everything was handwritten. The schematics I mentioned were drawn by the engineers, not by the draftsmen who normally do that job.

[R. Addendum to Appdx., Vol. IV at pp. 6a and 10a].

After successfully copying Milgo's modem, Rixon began marketing commercially acceptable 2400 bps and 4800 bps modems during the latter part of 1970. Prior thereto, Milgo was the only source of commercially acceptable 4800

bps modems and it was considered the sole source of 2400 bps modems capable of operating on unconditioned switched telephone lines; furthermore, prior thereto Milgo had also built strong business relationships with large accounts, including Burroughs Corporation and Honeywell Information Systems, which it lost to Rixon. This resulted after Rixon was able to force prices down and underbid Milgo.

Milgo filed the instant suit on July 19, 1971, alleging infringement of its Whang '023 patent. Thereafter, on September 25, 1972, Milgo amended its complaint to allege the infringement of its Ragsdale '381 and Payne '023 patents. United Telecommunications, Inc. (United) and UBC, its wholly-owned subsidiary, were named as defendants. In their answers, United and UBC denied the validity of each patent and both denied infringement.

In upholding the Milgo patents the District Court found, *inter alia*: The Milgo patents were, in all respects, valid and subsisting in law as to the claims in question; the inventions defined in the claims in question would not have been obvious to one of ordinary skill in the art at the time the invention thereof was made; each of the inventions, as to the claims in question are novel and useful and meet the requirements of 35 U.S.C.A. §§ 101 and 102; evidence of copying is properly admissible on the issues of obviousness and infringement; the unobvious requirement of 35 U.S.C.A. § 103 is fulfilled by an inventor who makes a new and useful improvement where those skilled in the art have failed after repeated efforts to do so; the Milgo patents as to the claims in question have been infringed by Rixon II by its manufacture and sale of the accused data sets, and by UBC by the sale of the accused data sets infringing the Whang '023 patent until January 1, 1972; and after January 1, 1972, UBC actively induced the infringement of the Milgo patents by and through

Rixon II. The court also determined that United was not liable for the infringement of any of the three patents.

On appeal UBC contends: (1) the Whang '023 patent is invalid; (2) copying is a non-issue; (3) UBC did not infringe any of Milgo's patents; and (4) the Payne '023 and Ragsdale '381 patents are invalid.

1.(a)

UBC contends the Whang '023 patent is invalid as obvious under 35 U.S.C.A. § 103 and invalid as "described in a printed publication * * * or in public use or on sale * * * more than one year prior to the date of the application for patent" under 35 U.S.C.A. § 102(b) and *Muncie Gear Works, Inc. v. Outboard Marine & Mfg. Co.*, 315 U.S. 759 (1942).

35 U.S.C.A. § 103 provides in part:

> A patent may not be obtained though the invention is not identically disclosed or described * * * if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. * * *

UBC contends, citing to *Graham v. John Deere Co.*, 383 U.S. 1 (1966) that obviousness is to be considered in light of the prior art, the differences between the prior art and subject matter claims, the level of ordinary skill in the pertinent art, along with "[s]econdary considerations such as commercial success, long felt but unresolved needs and the prior failure of others may be utilized as indicia of obviousness." UBC contends that the "alleged invention of the Whang '023 patent is nothing more than an

aggregation of ideas which were known to the art, and the result of which was completely predictable."

The ultimate determination of patent validity is, of course, one of law. *Moore v. Schultz,* 491 F.2d 294 (10th Cir. 1974); *Hinde v. Hot Sulphur Springs, Colorado,* 482 F.2d 829 (10th Cir. 1973). Patentability depends on numerous factors we identified in *A. E. Staley Manufacturing Company v. Harvest Brand, Inc.,* 452 F.2d 735 (10th Cir. 1971), *cert. denied,* 406 U.S. 974 (1972):

> The question of invention and thus, patentability, is one of fact involving consideration of novelty, utility, commercial success, satisfaction of long-felt want, unsuccessful efforts of others, public acquiescence in validity, imitation, experiments, and independent production by others. 69 C.J.S. Patents § 70 (1951).
>
> 452 F.2d at p. 739.

A regularly issued patent is presumed valid, and when the patent office has considered prior art in accepting or rejecting an allegation of anticipation, the presumption is strengthened. *Scaramucci v. Dresser Industries, Inc.,* 427 F.2d 1309 (10th Cir. 1970). The presumption of validity may be rebutted by the showing of obviousness. *Halliburton Company v. Dow Chemical Company,* 514 F.2d 377 (10th Cir. 1975). When the teachings in the prior art must be ignored to reach a desired result, they become less pertinent to the determination of obviousness. *CMI Corporation v. Metropolitan Enterprises, Inc.,* 534 F.2d 874 (10th Cir. 1976).

An invention that is obvious is an unpatentable invention. *Plastic Container Corporation v. Continental Plastics of Oklahoma, Inc.,* 607 F.2d 885 (10th Cir. 1979). Obviousness turns not on whether a device has, essentially, been produced, but on whether, though not yet produced,

it would have nevertheless been conceivable to a worker of ordinary skill in that field. *True Temper Corporation v. CF&I Steel Corporation,* 601 F.2d 495 (10th Cir. 1979). In each instance, the prior art must be carefully scrutinized. *Deere & Company v. Hesston Corporation,* 593 F.2d 456 (10th Cir. 1979). In order for a prior art to anticipate a process, it must disclose identical or equivalent steps to accomplish the same result. *CMI Corporation v. Metropolitan Enterprises, Inc., supra.*

Obviousness must be determined by considering the scope and content of the prior art, the differences between the prior art and claims at issue, and the level of ordinary skill in the pertinent art. *Tanks, Inc. v. Reiter Industries, Inc.,* 545 F.2d 1276 (10th Cir. 1976) *citing to Graham v. John Deere Co., supra.* Obviousness requires factual determinations which are entitled to the usual respect accorded determinations of fact, and, as such, an appellate court is bound by the trial court's findings on obviousness unless they are determined to be clearly erroneous. *Rutter v. Williams,* 541 F.2d 878 (10th Cir. 1976); *CMI Corporation v. Metropolitan Enterprises, Inc., supra.* We are not a trial court and a case such as the one at bar cannot be tried *de novo* on appeal. *Halliburton Company v. Dow Chemical Company, supra; Hinde v. Hot Sulphur Springs, Colorado, supra.* These principles were succinctly stated in *True Temper Corporation v. CF&I Steel Corporation, supra:*

> Obviousness, of course, is to be assessed as of the time the invention in question was made and from the viewpoint of "a person having ordinary skill in the art to which said [invention] pertains." 35 U.S.C. § 103. The issue necessarily involves several basic factual inquiries, outlined in *Graham v. John Deere Co.,* 383 U.S. 1, 17, 86 S.Ct. 684, 15 L.Ed.2d 545, involving the scope and content of the prior art, the

differences between the prior art and the patent claims in issue, and the level of ordinary skill in the pertinent field. There is also to be considered, however, the general statutory presumption of validity which attaches to a patent once issued by the Patent Office. 35 U.S.C. § 282. See generally *Sidewinder Marine, Inc. v. Starbuck Kustom Boats and Products, Inc.*, 597 F.2d 201 (10th Cir., 1979). We must, therefore, in reviewing the findings of the trial court, consider whether they are supported by the record or are clearly erroneous under the standard of Rule 52, F.R. Civ.P., taking into account the presumption of validity of the patent. *See CMI Corp. v. Metropolitan Enterprises, Inc.*, 534 F.2d 874, 880 (10th Cir.)

601 F.2d at p. 505.

Applying these standards, we hold that the Court did not err in finding that the Whang '023 was not obvious. The Court found, and we agree, that the Whang '023's utilization of differential eight phase modulation of a single carrier and narrow bandwidth filtering was contrary to the prior art; that Whang was the first to employ narrow band limiting in a phase modulated system; that modems incorporating the Whang '023 were the first commercially acceptable modems capable of transmitting 2400 bps over ordinary switched voice-grade telephone lines; that prior to the Whang '023 the modem industry felt the best results could be achieved by modems incorporating "wide band energy spectrum and two or four level modulation"; that Whang approached the problem with a completely opposite philosophy and was the first to combine eight level modulation and extreme band limiting into one modem.

The validity of the Whang '023 is also reinforced when we consider the "secondary considerations, such as commercial success" mandated by *Graham v. John Deere, supra.*

See also: Deere & Company v. Hesston Corporation, supra. It is uncontested that Western Union looked upon the Whang '023 as a tremendous breakthrough which satisfied a long felt need. It is also uncontested that the modems were instantly successful and that they were the primary source of commercially acceptable high speed modems until the infringing modems were marketed. We hold that the trial court properly found that Whang '023 was unobvious, and therefore valid. Query: If the Whang '023 was as obvious as UBC now contends, why did it require two years for the Rixon employees to analyze and copy it?

1.(b)

UBC contends that the Whang '023 is invalid under 35 U.S.C.A. § 102(b) and *Muncie Gear Works, Inc. v. Outboard Marine & Mfg. Co., supra,* since it was described in a printed publication, the original patent application, more than one year prior to the date the amended application was submitted. We hold that the Court properly applied *Price v. Lakes Sales Supply R.M., Inc.,* 510 F.2d 388 (10th Cir. 1974) in determining that the amendment was simply clarifying in form and only made express that which was always present in the original disclosure.

2.

UBC contends that "copying is a non-issue" and that the District Court gave too much consideration to actions and events which occurred prior to the issuance dates of the patents herein. UBC argues that since Milgo did not claim damages for violation of trade secrets nor for "appropriation of trade dress or misrepresentation or misappropriation of non patented material or contract protected subject matter", the District Court improperly gave undue attention to matters which occurred prior to the

issuance of the patents herein. This Court has consistently held that the exercise of fraud, inequitable conduct, or bad faith in the prosecution of a patent application may result in the unenforceability of a patent ultimately issued. *True Temper Corp. v. CF&I Steel Corporation, supra,* and cases cited therein. In an analogous vein, we believe that trial courts are empowered, and in fact obligated, to determine the presence of "fraud, inequitable conduct, or bad faith" in patent infringement litigation, once a patent is issued. We do not accept UBC's assertion that the District Court improperly made copying an issue; the Court correctly considered evidence of Rixon's copying. However we are disinclined to hold that this evidence was considered out of order in derogation of the Court's determination upholding the patent's validity. The Court did not, in any event, overextend or enlarge upon the issue of copying in derogation of UBC's trial rights and privileges, since, as the Court properly noted, evidence of copying is admissible on the issue of obviousness, citing to *Mott Corporation v. Sunflower Industries, Inc.,* 314 F.2d 872 (10th Cir. 1963), and further admissible on the issue of infringement, citing to *Lever Brothers Co. v. Procter & Gamble Mfg. Co.,* 139 F.2d 633 (4th Cir. 1943). In *Mott, supra,* we stated:

> Appellees insist, however, that the Mott blades are improvements which would be obvious to the ordinary skilled workman. The trouble with this argument is that the record clearly shows there had long been a demand for a mowing machine which would successfully cut all types of grass under all conditions. *The fact that appellees were unsuccessful in their efforts to develop such a machine and made a virtual "Chinese copy" of the Mott mower is persuasive on the issue of obviousness.* The patent in suit may be simple when viewed in retrospect. But

simplicity is no bar to invention where, as here, the steps taken were not obvious to the ordinary mechanic skilled in the art. Admiral Corporation v. Zenith Radio Corporation, supra; Blish, Mize and Silliman Hdwe. Co. v. Time Saver Tools, supra; Neff Instrument Corporation v. Cohu Electronics, Inc., 9 Cir., 298 F.2d 82; Amp Incorporated v. Vaco Products Co., 7 Cir., 280 F.2d 518, cert. denied, 364 U.S. 921, 81 S.Ct. 286, 5 L.Ed.2d 260.

314 F.2d at p. 880. [Emphasis supplied].

3.

UBC contends it did not infringe on any of the Milgo patents. UBC argues that the Court improperly determined that its DS-4800 modem infringed upon the Whang '023, the Payne '023, and the Ragsdale '381 patents. The question of infringement is one of fact, *Burger Train Systems, Inc. v. Ballard,* 552 F.2d 1377 (10th Cir. 1977), *cert. denied* 434 U.S. 860 (1977), and, on review, a trial court's finding thereon will not be set aside unless it is clearly erroneous. *Black, Sivalls & Bryson, Inc. v. Keystone Steel Farication,* 584 F.2d 946 (10th Cir. 1978). We do not try factual matters, such as infringement, de novo. *Halliburton Company v. Dow Chemical Company, supra.*

In determining that the Payne '023 and Ragsdale '381 had been infringed, the Court found:

82. The accused DS-4800 data set includes each and every element recited in claims 1-19 and 21 of the Ragsdale '381 patent in suit or an equivalent thereof. Each of the elements of the DS-4800 data set perform substantially the same function in substantially the same manner to obtain the same end results as do the corresponding elements of both the claims in suit of the Payne '023 and Ragsdale '381 patents (PX

20 and PX 19 respectively) as well as the corresponding elements of the patented Milgo 4400/48 modem which is covered by the Payne '023 and Ragsdale '381 patents.

83. Plaintiff's Exhibit 19 includes the claims at issue in the Ragsdale '381 patent colored with colors which are matched to corresponding elements of the DS-4800 as depicted in drawings from the DS-4800 manual, which drawings accurately depict and correctly represent the operation of the DS-4800. The claims of Ragsdale '381, element-by-element and function by function, were applied by Ragsdale and disclosed that each and every claimed element and function is present in the DS-4800 (R. 1167-1222).

84. Plaintiff's Exhibit 20 includes the claims at issue in the Payne '023 patent colored with colors which are matched to corresponding elements of the DS-4800 as depicted in drawings from the DS-4800 manual, which drawings accurately depict and correctly represent the operation of the DS-4800. The claims of the Payne '023 patent, element-by-element and function-by-function, were applied by Ragsdale and proved that each and every claimed element and function is present in the DS-4800 (R. 1134-1165).

[R. Appdx., Vol. I at p. 74-75].

We hold that the Court properly found that the Milgo patents in question were infringed.

4.

UBC contends the Payne '023 and Ragsdale '381 patents are invalid as "covering nothing more than obvious combinations of digital principles and logic hardware which were well known to those skilled in the art".

In upholding the validity of the Payne '023 and the Ragsdale '381 the Court found:

> 63. The Payne '023 patent led Ragsdale to the development of the Ragsdale '381 digital coherent detection patent (R. 1109-1117). The digital detector of the Ragsdale '381 patent accomplished phase locking of two signals of different frequencies in a restricted bandwidth modem in spite of the presence of repeated phase shifts in the same direction as acknowledged by defendants' expert Dr. Beam (R. 2086). Originally, Dr. Beam asserted that the Kawai patent (DX Z) and Lender patent (DX A-1) showed the method of deriving a reference carrier for coherent detection. However, Dr. Beam finally admitted that phase locking two such sinusoidal signals of different frequencies was a difficult task (R. 2066), and further admitted that he knew of no prior art that did what Ragsdale did in the '381 patent and that included all the technical things that Dr. Beam could think of (R. 2087). Defendants' own technical expert admitted that the Ragsdale '381 patent distinguishes over the prior art he was aware of, and the claimed features of the Ragsdale '381 patent represents significant and non-obvious improvements over all prior art known by defendants' technical expert.
>
> 64. The Bennett & Davey textbook (DX J-1) represents the state of the art that existed prior to the invention date of the Ragsdale '381 patent. That textbook at page 258 taught that it was "impossible" to do what Ragsdale did in his '381 patent.
>
> * * *
>
> 65. The defendants attempted to reconstruct the principles of the Payne '023 and Ragsdale '381 patents from a paper by Wilson (DX I-2). The Wilson paper

includes a box labeled "computer" where there could be almost anything, including a general purpose computer (R. 2041, 2042, 2046, 2047). Dr. Beam admitted that even a general purpose computer in Wilson would have to be modified to accomplish the principles of the Payne '023 and Ragsdale '381 patents (R. 2046-2048). The circuits of the Payne '023 and Ragsdale '081 patents were admitted by Dr. Beam as being novel over the functions of the general purpose computer of Wilson (R. 2048-2054). The Payne '023 and Ragsdale '381 patents define features which represent significant and non-obvious improvements over DX I-2.

* * *

68. Analog detectors such as those disclosed by DX G-1, DX Z and DX A-1, suffer from many problems associated with analog detectors, which problems as testified to by Ragsdale, were overcome by the digital detectors of the Payne '023 and Ragsdale '381 patents (R. 1035-1039, 1112; R. 2438, 2439). The digital detectors of the Payne '023 and Ragsdale '381 patents represent significant and non-obvious improvements over the analog detector of the HC-270 described in DX G-1, and over the analog detectors of DX Z and DX A-1.

69. Ragsdale testified that none of the defendants' exhibits that Dr. Beam referenced taught or suggested the claimed features of the Payne '023 or the Ragsdale '381 patents (R. 2442). None of the references introduced by the defendants teach or suggest the significant improvements over the prior art that are provided by the claimed features of the Payne '023 and Ragsdale '381 patents (R. 2442). The defendants have not cited any prior art that is any more pertinent to the Payne '023 or Ragsdale '381 patents than that

cited by the Patent Office in the prosecution and issuance of the Payne '023 and Ragsdale '381 patents (DX B and DX C).

70. All of the patents testified to by Dr. Beam with reference to the three patents in suit were present either in the file histories of the three patents in suit or were present in the classes and sub-classes (PX 168, 169) which were searched by the Patent Office Examiners in conjunction with the prosecution and issuance of the three patents in suit. The defendants did not introduce any prior art having teachings that rebut the presumption of validity which is awarded in patents in suit upon their issuance by the U. S. Patent Office (PX 168 and 169, R. 1690-1692).

[R. Appdx., Vol. I at pp. 63, 64, 67 and 68].

Without repeating our prior discussions relative to the presumed validity of a patent once issued, the issue of obviousness and the weight to be afforded to findings of a trial court within the context of the clearly erroneous rule, we hold that the Court properly found the Payne '023 and Ragsdale '381 patents to be valid.

II.

Agency Relationship

UBC contends there are no factual findings and no evidence supporting the trial court's conclusion that Rixon II was the mere instrumentality, alter ego, or agency of UBC. A discussion of the corporate history of United, UBC and Rixon II, will facilitate our review.

United is a corporation organized and existing under the laws of Kansas, which is, and has at all times since November 15, 1938, existed as a holding company. As such it is without operating divisions. United, as a holding

company, owns the stock of a number of companies called the United Telephone System.

During 1968, Rixon Electronics Corporation (Rixon I) procured a Milgo modem and began copying it. Thereafter, on or about October 24, 1968, an agreement was reached between Rixon I and United under which a subsidiary would be formed by United for acquiring the business and assets of Rixon I in exchange for United stock. This agreement was followed by an Agreement and Plan of Reorganization dated December 12, 1968.

On May 23, 1969, United caused to be organized a Maryland corporation named New Rixelco, Inc. (Rixon II) as a wholly owned subsidiary. Thereafter, on July 3, 1969, United issued 597,105 shares of its common stock to Rixon I, and Rixon I transferred and conveyed its business and assets to Rixon II. In effectuating the transfer Rixon I withheld certain monies and securities to satisfy the anticipated expenses of the transaction, and Rixon II assumed all of the liabilities and obligations of Rixon I existing at the date of the transaction, with the exception of the expenses of the transaction to be satisfied by Rixon I and certain outstanding stock options for Rixon I's employee stock option plan which were assumed by United. (On July 11, 1969 Rixon changed its name to Rixon Electronics, Inc.; however, this name change is of no moment on appeal.)

UBC was organized as a Kansas corporation, and a wholly owned subsidiary of United on January 5, 1970. UBC was organized to engage in the business of selling, engineering, installing, and servicing private voice and data communications equipment. Thereafter on June 24, 1970, United transferred all of the Rixon II stock to UBC, making Rixon II a wholly owned subsidiary of UBC. Commencing in July, 1970, UBC began marketing certain prod-

ucts of Rixon II, including the infringing modems in controversy herein.

On January 1, 1972, by mutual agreement of their respective officers, UBC discontinued marketing data modems and Rixon II began its own marketing. UBC's inventory of data modems was thereafter held for Rixon II; payment therefor from Rixon II to UBC was made as Rixon II sold the modems. Since January 1, 1972, UBC has not sold any of the infringing modems.

On or about October 1, 1972, pursuant to an agreement between United, UBC, Rixon II and Sangamo Electronic Company, Rixon II conveyed all of its business and assets to a newly formed corporation, Rixc Inc. (Rixon III), a Delaware corporation. Rixon III was formed and has operated as a subsidiary of Sangamo Electric, which owns 60% of Rixon III's equity and has an option to purchase the remaining 40% from United. Since October 1, 1972, Rixon III has not been involved in the manufacture or sale of the infringing devices.

In ruling that Rixon II was a mere instrumentality, alter ego, or agency of UBC, the trial court cited with approval *Quarles v. Fuqua Industries, Inc.*, 504 F.2d 1358 (10th Cir. 1974), wherein we stated:

> Thus a holding or parent company has a separate corporate existence and is treated separately from the subsidiary in the absence of circumstances justifying disregard of the corporate entity. 18 Am.Jur. 2d Corporations § 17 (1965). *See* Continental & Commercial Trust & Sav. Bank v. Garden City Co., 123 Kan. 659, 256 P. 983 (1927). Circumstances justify disregard of the corporate entity if separation of the two entities has not been maintained and injustice would occur to third parties if the separate entity were recognized.

Garden City Co. v. Burden, 186 F.2d 651 (10th Cir. 1951).

In Flank Oil Co. v. Continental Oil Co., 277 F.Supp. 357, 363 (D.Colo. 1967), Judge Doyle said:

> Cases such as *Steinway* properly discount formal separations of function and subtle efforts to maintain distinct corporate entities. The effort is to ascertain from the total facts the extent of actual control exercised by the parent over the internal affairs of its subsidiary . . . .
>
> * * *
>
> The trial court specifically held Career was not the agent of Fuqua. This conclusion can only be reversed if it is clearly erroneous. Manufacturer's Nat'l Bank v. Hartmeister, 411 F.2d 173 (10th Cir. 1969).

504 F.2d at pp. 1362 and 1364.

Quarles, supra, was cited with approval by this Court in *G.M. Leasing Corp. v. United States,* 514 F.2d 935 (10th Cir. 1975), *reversed on other grounds,* 429 U.S. 338 (1977), for the proposition that a trial court's finding that an entity is not an alter ego is presumptively correct and cannot be disturbed absent clear error:

> Appellants first challenge the trial court's finding that appellee was not taxpayer's alter ego. This finding is presumptively correct and must be left undisturbed on appeal unless it is clearly erroneous. Quarles v. Fuqua Industries, Inc., 504 F.2d 1358 (10th Cir. 1974). A finding is clearly erroneous when, although there is evidence to support it, the reviewing court is left with the definite and firm conviction that a mistake has been committed. *See, e. g.,* Kelson v. United States, 503 F.2d 1291 (10th Cir. 1974); Clancy

v. First Nat'l Bank, 408 F.2d 899 (10th Cir. 1969), cert. den'd, 396 U.S. 958, 90 S.Ct. 430, 24 L.Ed.2d 422.

514 F.2d at p. 939.

In *Fish v. East,* 114 F.2d 177 (10th Cir. 1940), this Court set out some factors relevant in determining whether the corporate veil, in the parent-subsidiary context, should be pierced:

> (1) The parent corporation owns all or majority of the capital stock of the subsidiary. (2) The parent and subsidiary corporations have common directors or officers. (3) The parent corporation finances the subsidiary. (4) The parent corporation subscribes to all the capital stock of the subsidiary or otherwise causes its incorporation. (5) The subsidiary has grossly inadequate capital. (6) The parent corporation pays the salaries or expenses or losses of the subsidiary. (7) The subsidiary has substantially no business except with the parent corporation or no assets except those conveyed to it by the parent corporation. (8) In the papers of the parent corporation, and in the statements of its officers, "the subsidiary" is referred to as such or as a department or division. (9) The directors or executives of the subsidiary do not act independently in the interest of the subsidiary but take direction from the parent corporation. (10) The formal legal requirements of the subsidiary as a separate and independent corporation are not observed.

114 F.2d at p. 191.

In the instant case there is no evidence that formal legal requirements of separateness were ignored, but the record contains evidence at least tending to support the following findings. UBC owned all of the stock of Rixon

II; the directors of UBC and Rixon II were "virtually" the same; although UBC did not finance Rixon II, United Utilities, which owned UBC, provided the operating capital for both UBC and Rixon II through loans or by guaranteeing loans; Rixon II and UBC were caused to be organized by United Utilities; capital was grossly inadequate in that it came from loans that Rixon could not have repaid; although Rixon II paid its own officers and employees, it had to borrow from United Utilities to pay its operating expenses; prior to the retransfer of the marketing functions, all commercial sales activities for Rixon products, except government sales, were in the hands of UBC—thus nearly all its products were sold to UBC. After the transfer of the marketing functions back to Rixon II in 1972, the subsidiary was apparently treated as the "Rixon Division" of UBC. [R. Appdx., Vol. VII at pp. 869E, 878E].

With respect to category (9) set out above, the trial court made findings that Rixon II acted independently of United's subsidiaries were at arm's length, and that in various specific respects Rixon II operated as an independent corporation. But other findings and evidence tend to show an overlapping business relationship controlled by UBC, and particularly by Robert Liepold, president and chief executive officer of UBC. Liepold also was chairman of the board of Rixon II, but not its chief executive officer and apparently not on its payroll.

The lack of independence and blurring of separateness is evidenced by the very detailed monthly operating reports Rixon II was required to give Liepold and UBC [R. Appx., Vol. VIII at pp. 1230E-1338E], and UBC's detailed review of Rixon II's decisions, [*See id.* Vol. IV at pp. 1665-1669], and by evidence that Liepold exercised powerful decision-making authority over Rixon II, including selection of the board of directors, [*Id.* at p. 1675], initiation of the decision,

with the president of Rixon II, to transfer modem marketing activities back to Rixon II, [*Id.* at pp. 1628, 1652], and establishment with Rixon II's president of the pricing guidelines for Rixon II to follow after the transfer, [*Id.* Vol. VII at pp. 868E-69E] (UBC set those prices unilaterally while it had the marketing function). [*Id.* Vol. IV at pp. 1658-59]. In addition, the record contains evidence that in paying Rixon II for the modems UBC marketed, UBC purposefully timed the payments to benefit Rixon II's financial position, [*Id.* Vol. IV at pp. 1660-61], or in one case, to achieve "a more efficient use of cash for the consolidated operation," [*Id.* Vol. VII at p. 573E] (Rixon II operating report for November 1970), although Rixon II thereby incurred additional interest costs in connection with other indebtedness that could not be reduced. A letter dated January 18, 1971, sent by the treasurer of Rixon II to Liepold concerning a UBC proposal that Rixon II lease certain equipment appears to exemplify the relationship between those entities. In pertinent part, the letter states as follows:

> Maury has requested that I respond to UBC's proposal for Rixon to lease the ARD 561 PBX as presented in Rick Johnson's letter of January 12, 1971.
>
> As a matter of form we would like to advise you that normally Rixon, dealing at arms [sic] length in this kind of transaction, would not sign a purchase order authorizing a lessor to purchase on our behalf a complex system for which the lessor would be relieved of all responsibility for operating performance.
>
> * * *
>
> After consideration of the above, if UBC believes that it is in the best interests of the consolidated UBC-Rixon operation for Rixon to enter into the lease

agreement, as Rick has requested, it will be appreciated if you would have UBC's authorized representative write us a letter advising Rixon of this decision.

[R. Appdx., Vol. VIII at pp. 1455E-56E].

Most of the evidence discussed above is from the time period preceding the retransfer of the marketing functions, but it also tends to support the conclusion that UBC control over Rixon II continued from the date of the retransfer until the formation of Rixon III. In addition, the record shows that Rixon II continued to supply Liepold with detailed operating reports. *See, e.g., Id.* Vol. VIII at 1230E-1311E. The inventory retransferred to Rixon II was retained physically by UBC in its warehouse for Rixon II; Rixon II did not pay for the inventory until it sold the products to its customers. The transfer price was UBC's original acquisition cost plus interest from January 1, 1972. UBC's warehouse was contiguous to Rixon II's building and manned by Rixon II employees, for which UBC recompensed Rixon II on a monthly basis. [*Id.* Vol. III at 1063-64]. As noted above, Liepold continued to play a significant role in Rixon II's pricing decisions. These arrangements inferentially support a continuing sharing of functions that belies separateness of the concerns. In addition, a letter dated July 26, 1972, sent from Rixon II's treasurer to his counterpart at UBC seems to evidence the continuing control of UBC. The letter states in pertinent part as follows:

Terry and I have been discussing several kinds of billings UBC has been making to Rixon and question whether (1) we either have the authority to accept such items on behalf of Rixon, or (2) the items really should not remain with UBC and be disposed of as a UBC cost factor. We understand that under a product line profit and loss concept, these billings would be charged to Rixon.

However, in view of the corporate division of responsibility, we ask that you reconsider the following items for the reasons stated and accept debit memo as a charge back to UBC.

* * *

If you people feel you can accept this, please advise. We will prepare our debit as a July item. *If you have a problem with this, please refer the matter to Bob Liepold, who probably should arrange for formal instructions to be delivered to Rixon.*

[R. Appdx., Vol. VIII at pp. 1218E-20E]. [Emphasis supplied].

We do not say the inference of alter ego or agency is compelled by the evidence. Mere ownership of stock is not enough to pierce the corporate veil; there must be enough commingling of business and assets that honoring the legal fiction of separateness results in injustice. *See: International Union, UAW v. Cardwell Mfg. Co.*, 416 F.Supp. 1267, 1286 (D. Kan. 1976). Most of the cases have involved fraud or a more blatant commingling than the instant case; but proof of fraud is not a necessary element in finding alter ego. *E.g., DeWitt Truck Brokers, Inc. v. W. Ray Flemming Fruit Co.*, 540 F.2d 681, 684 (4th Cir. 1976).

In our review of the trial court's findings we must apply a "clearly erroneous" test. Fed. R. Civ. P. 52(a). We do not reverse unless upon review of the evidence we are "left with the definite and firm conviction that a mistake has been committed." *United States v. United States Gypsum Co.*, 333 U.S. 364, 395 (1948). We have reviewed the record carefully and, applying that standard, must affirm the alter ego finding.

III.

Damages

UBC contends that the damages awarded were not supported by evidence and were clearly erroneous; that the trial court's computations of Milgo's lost sales and leases are unsupported and clearly erroneous; and that the Court abused its discretion by awarding attorney fees and prejudgment interset.

In awarding damages to Milgo the Court entered eleven conclusions of law, including, *inter alia*:

> 4. Defendant is liable for damages caused by actual deliveries of the DS-2400 data sets from July 28, 1972 through September 30, 1972 (the date of transfer of Rixon II to Rixon III), by Rixon II or UBC.
>
> 5. Milgo is entitled to recover damages as to the sales which it would have made but for the infringement, based on the entire profit which Milgo would have received from such sales. Under the circumstances, Milgo is awarded its lost profits on all deliveries (sales or leases) by defendant. *Ingersoll-Rand v. Brunner & Lay*, 182 U.S.P.Q. 257; *National Rejectors v. A.B.T. Mfg. Corp.*, 188 F.2d 706 (7th Cir. 1951); *Livesay Window Co. v. Livesay Industries*, 251 F.2d 469 (5th Cir. 1958).
>
> 6. Where the wrong done Milgo in this case is so absolute, the consequences of any inability to demonstrate Milgo's loss with scientific accuracy is a burden that must be met by the infringer. *Livesay*, supra; *H. K. Porter Co., Inc. v. Goodyear Tire & Rubber Co.*, 536 F.2d 1115 (6th Cir. 1976). All doubts occasioned by Rixon/UBC's failure to keep proper records are to be resolved in favor of Milgo. *Georgia Pacific Corp. v. United States Plywood Corp.*, 243

F.Supp. 500, 509 (S.D.N.Y. 1965); *American Sterilizer v. Sybron Corp.*, 426 F.2d 542, 548-549 (3d Cir. 1975).

7. The award of damages for loss by Milgo of sales and leases of the patented modems copied by the defendant is proper, even though the defendant may not have made any profit of its own on the sale and lease of the infringing modems. *Yale Lock Mfg. Co. v. Sargent,* 117 U.S. 536 (1885).

8. In view of defendant's willful and deliberate infringement and the unusual lengths to which defendant went in copying Milgo's inventions, this is an exceptional case. In such circumstances, Milgo is entitled to treble damages, costs, expenses and attorney's fees because defendant has knowingly, deliberately, willfully and wantonly infringed the patents. 35 U.S.C.A. §§ 271 through 287. *Maxon Premix Burner Co. v. Mid-Continent Metal Prod. Co.,* 279 F.Supp. 164 (N.D.Ill. 1967).

[R. Appdx., Vol. I at pp. 131-132].

The trial court thereafter awarded damages to Milgo for its lost profits on sales and leases by UBC and Rixon of the infringing modems in the total amount of $621,968.00. This figure was trebled in accordance with 35 U.S.C. § 284. The court added prejudgment interest from July 19, 1971, the date of the last infringement, to the date of judgment at the rate of 6 percent; attorneys' fees of $250,000.00, and costs of $14,409.65. The total damage award was $2,340,726.23, plus postjudgment interest at the rate of 8 percent.

UBC challenges the award on several grounds. First, UBC contends that the trial court erred by using lost profits rather than reasonable royalties as the measure of damages. Second, UBC asserts that the judge erred in his calculation of lost profits. Specifically, UBC con-

tests the percentage value assigned as Milgo's profit margin, the treatment of certain leases as sales, and the inclusion of pre-accounting-period leases in damage computations. Third, UBC attacks the trial court's finding that the infringement was deliberate and willful, which provided the basis for the court's award of treble damages, attorneys' fees and prejudgment interest. With respect to the award of attorneys' fees, UBC argues that even if the award is proper, there is insufficient evidence that the amount awarded was reasonable.

In reviewing the trial court's award in this case, it is important to bear in mind the principle that the trial judge has considerable latitude in assessment of damages in patent infringement actions. *Maloney Crawford Tank Corp. v. Sauder Tank Co.*, 511 F.2d 10, 13 (10th Cir. 1975); *Allen v. W.H.O. Alfalfa Milling Co.*, 272 F.2d 98 (10th Cir. 1959). An appellate court must affirm the award if there is substantial record evidence to support it: the trial court's findings will not be set aside unless it is shown that they are clearly erroneous. *H. K. Porter Co. v. Goodyear Tire & Rubber Co.*, 536 F.2d 1115, 1122 (6th Cir. 1976); *Maloney Crawford Tank Corp. v. Sauder Tank Co., supra.* UBC's arguments on this appeal are not altogether without merit. Nevertheless, considering the whole record in this case, it is our view that the trial court's estimation of Milgo's damages falls well within a reasonable range, and should not be disturbed.

a. Lost Profits

In order to recover lost profits rather than merely a reasonable royalty in a patent infringement action, the patentholder must demonstrate that "but for" the infringement, he would have made the sales that the infringer made. *Hughes Tool Co. v. G. W. Murphy Industries, Inc.*, 491 F.2d 923, 929 (5th Cir. 1973); *Livesay Window Co.*

v. Livesay Industries, Inc., 251 F.2d 469, 471-72 (5th Cir. 1958); *Power Specialty Co. v. Connecticut Light & Power Co.*, 80 F.2d 874, 875 (2d Cir. 1936). No presumption operates in the patent-holder's favor that he would have made the sales in question. *Broadview Chemical Corp. v. Loctite Corp.*, 311 F.Supp. 447, 450 (D. Conn. 1970). The patent-holder must advance affirmative proof of the demand for his patented product in the marketplace, the absence of acceptable non-infringing substitutes, and his production and marketing capacity to meet the demand. *Panduit Corp. v. Stahlin Bros. Fibre Works, Inc.*, 575 F.2d 1152, 1156 (6th Cir. 1978).

Yet, the "but for" rule necessarily expresses an hypothesis. Neither the trial court nor the appellate court can demand absolute proof that purchasers of the infringing product would have bought the patent-holder's product instead. It is impossible and therefore unnecessary for the patent-holder to negate every possibility that the purchasers might not have bought another product. *W. L. Gore & Assoc., Inc. v. Carlisle Corp.*, 198 U.S.P.Q. 353, 361 (D. Del. 1978); *Broadview Chemical Corp. v. Loctite Corp., supra*, 311 F.Supp. at 451. The plaintiff's burden of proof is not absolute, but rather one of reasonable probability:

> If in all reasonable probability, the Patent Owner would have made the sales which the Infringer has made, what the Patent Owner in reasonable probability would have netted from the sales denied to him is the measure of his loss, and the Infringer is liable for that.

Livesay Window Co. v. Livesay Industries, Inc., supra. *See also: Hughes Tool Co. v. G. W. Murphy Industries, Inc., supra; W. L. Gore & Assoc., Inc. v. Carlisle Corp., supra; Broadview Chemical Corp. v. Loctite Corp., supra.*

The trial court found that Milgo and Rixon/UBC were the only viable competitors in the marketplace, and

that "in all reasonable probability" Milgo would have made the sales of the infringing modems if Rixon/UBC had not made them. UBC contends that Milgo did not satisfy its burden of proof, arguing that Milgo was required to show that it bid or solicited bids on all the sales allegedly lost to Rixon/UBC, and that there is no evidence that Milgo did so. UBC's argument has no merit. Where the plaintiff and the defendant in a patent infringement action are the sole competitors in the marketplace, it is unnecessary for the plaintiff to prove that he bid or at least solicited bids on every infringing sale in order to recover lost profits for these sales. *See Electric Pipe Line, Inc. v. Fluid Systems, Inc.*, 250 F.2d 697, 699 (2d Cir. 1957); *W. L. Gore & Assoc., Inc. v. Carlisle Corp., supra,* 198 U.S.P.Q. at 362. UBC relies principally on *General Electric Co. v. Sciaky Bros., Inc.*, 415 F.2d 1068 (6th Cir. 1969), but in that case, the fact that the patent owner had not bid on the lost sales became significant only bceause it was clear on the evidence that the plaintiff had important competitors other than the infringer. *See id.* at 1076.

In this case, the record fully supports the trial court's conclusion that Milgo and Rixon/UBC were the only viable competitors in the market. Only the modems manufactured and sold by Milgo and Rixon/UBC had the capacity to operate on unconditioned telephone lines. This represented a savings of from $40 to $80 per month per line for users, and in addition meant that the modem would provide more reliable operation over a longer period of time, notwithstanding changes in the characteristics of the transmission line occurring after installation. Thus Milgo's failure to offer evidence that it had bid on all of Rixon/UBC's infringing sales is not fatal to Milgo's lost profits claim. The trial court's determination that lost profits were the appropriate measure of damages was correct.

b. Calculation of Lost Profits

The court found that Milgo's profit margin on lost sales due to infringement would have been 43.4% for the years 1970-1972. The court did not include Milgo's general administrative (G&A) or research and development (R&D) expenses in the profit margin figure because it found that the increase in sales would not have required additional G&A or R&D expenses. The profit margin figure was multiplied by the average sales price of comparable Milgo modems during the same years to arrive at a per unit lost profit figure.

The purpose of a damage award for patent infringement is to give the plaintiff reasonable and full compensation for the loss incurred because of the patent infringement. Calculation of lost profits is by its nature imprecise. "Lost profits cannot be computed with certainty; they are hypothetical by definition. The 'reasonable certainty' test . . . is no more than a test of probability as it must be in dealing with a hypothetical situation." *H. K. Porter Co., Inc. v. Goodyear Tire & Rubber Co., supra.* The authorities are clear that in awarding lost profits, reasonable probability rather than precision is required. *Story Parchment Co. v. Paterson Parchment Paper Co.*, 282 U.S. 555, 562 (1931); *Livesay Window Co. v. Livesay Industries, Inc., supra; W. L. Gore & Assoc., Inc. v. Carlisle Corp., supra.*

It is also true that doubts concerning the calculations of profits must be resolved against the infringer. The Supreme Court summed up this reasoning in *Story Parchment Co. v. Paterson Parchment Paper Co., supra*, 282 U.S. at 562:

> Where the tort itself is of such a nature as to preclude the ascertainment of the amount of damages with certainty, it would be a perversion of fundamental

> principles of justice to deny all relief to the injured person, and thereby relieve the wrongdoer from making any amend for his acts. In such case, while the damages may not be determined by mere speculation or guess, it will be enough if the evidence show the extent of the damages as a matter of just and reasonable inference, although the result be only approximate. The wrongdoer is not entitled to complain that they cannot be measured with the exactness and precision that would be possible if the case, which he alone is responsible for making, were otherwise .... [T]he risk of uncertainty should be thrown upon the wrongdoer instead of upon the injured party. [Citations and footnotes omitted].

This standard and reasoning has been expressly applied to problems in assessing damages in patent cases. *Livesay Window Company v. Livesay Industries, Inc., supra.*

The rule against requiring precision in proving the extent of lost profits once infringement is established is further softened when the inability to prove lost profits is due to the infringer's own failure to keep accurate or complete records. The consequences of such failure must rest on the infringer. *American Sterilizer Co. v. Sybron Corp.*, 526 F.2d 542 (3d Cir. 1975); *Georgia Pacific Corp. v. United States Plywood Corp.*, 243 F.Supp. 500 (S.D. N.Y. 1965).

All of these principles were very relevant to the facts in this case and were properly applied by the trial court. Viewing the entire circumstances of the case, the damage assessment appears equitable and conservative. While it is true that some of the calculations used in assessing damages contain a degree of uncertainty, that is a necessary result of the nature of the case and is not a ground

for modification or reversal. The trial court considered the evidence, it did not merely adopt the assertions of the plaintiffs.

c. *Willfulness*

35 U.S.C.A. § 284 provides the trial court in patent cases with discretion to increase the damage award to the plaintiff where the defendant's conduct is intentional, willful and made with reckless disregard of the plaintiff's patent rights:

* * *

> When the damages are not found by a jury, the court shall assess them. In either event the court may increase the damages up to three times the amount found or assessed.

* * *

An award of increased or trebled damages is a matter committed to the discretion of the trial court under this statute. Hence, an appellate court can disturb such an award only on a showing of abuse of the trial court's discretion. *Blake v. Bassick Co.*, 392 F.2d 879, 883 (7th Cir.), *cert. denied*, 393 U.S. 828 (1968); *Marvel Specialty Co. v. Bell Hosiery Mills, Inc.*, 386 F.2d 287, 292 (4th Cir. 1967), *cert. denied*, 390 U.S. 1030 (1968).

UBC contends that there was insufficient evidence to support the court's findings that Rixon copied that Milgo modem and that Rixon/UBC had actual notice of infringement on the date that the Whang '023 patent issued. In view of the record, this argument is wholly without merit. Indeed, UBC appears to realize the weakness of this argument, since insufficiency of the evidence is *not* the principal ground upon which UBC argues for reversal of the willfulness finding.

UBC contends that any copying endeavors that occurred prior to the date of issuance of the patents cannot support a finding of willful infringement. A patent application for the Whang '023 was filed on July 14, 1966, but the Milgo Model 4400/48 modem which was covered by this patent and which was copied by UBC was not marked "patent pending". The Whang '023 patent issued on August 11, 1970, and this was the earliest date on which the trial court found that UBC had actual knowledge of Milgo's patent rights. The copying activities took place before this, over a two-year time span beginning in the spring of 1968. UBC correctly notes that Milgo has not advanced any claim for common law misappropriation of trade secrets and that, under the patent laws, UBC's liability is limited to the period following the date of issuance of the patent. UBC's position is that at the time of the alleged copying activities, Milgo's Model 4400/48 modem was in the public domain, and that UBC had the legal right to acquire and study it.

It is true that copying a competitor's product which is not protected by the patent laws is not illegal. *Duplex Straw Dispenser Co. v. Harold Leonard & Co.*, 229 F.Supp. 401, 404 (S.D. Calif. 1964). *See also: Sears, Roebuck & Co. v. Stiffel Co.*, 376 U.S. 225 (1964); *Smith v. Dravo Corp.*, 203 F.2d 369 (7th Cir. 1953). And it is plain that there can be no liability for *infringement* before a patent issues. *Inject-O-Meter Mfg. Co. v. North Plains Fertilizer & Chemical, Inc.*, 308 F.Supp. 538, 541 (N.D. Tex. 1970), *aff'd* 439 F.2d 1138 (5th Cir. 1971), *cert. denied*, 404 U.S. 824 (1971) (prepatent copying does not constitute infringement); *Thomson Machinery Co. v. LaRose*, 306 F. Supp. 681, 693 (E.D. La. 1969). But unlike the cases cited by UBC to support its contention, the issue here is not infringement, but rather willfulness, that is, UBC's state of mind. UBC's copying efforts would not have been

actionable under the patent laws before 1970; UBC cannot be held liable for patent infringement before that time. Nevertheless, UBC's copying activities evidence that its conduct in manufacturing and selling infringing modems after 1970 was intentional and deliberate, in willful disregard of Milgo's rights, rather than merely accidental or negligent. UBC's copying activities belie its contention that it proceeded to manufacture and sell modems with a good-faith belief that there was no infringement.

Once UBC had actual notice of Milgo's patent rights, UBC was under an affirmative duty to exercise due care to determine whether or not it was infringing Milgo's patents. *Coleman Co. v. Holly Mfg. Co.*, 269 F.2d 660, 666 (9th Cir.), *cert. denied*, 352 U.S. 952 (1959). UBC did not heed the suggestion of its vice president Reed Manning that its modems might be infringing, and made no effort to secure an opinion from patent counsel. *Cf. Union Carbide Corp. v. Graver Tank & Mfg. Co.*, 282 F.2d 653, 660, 662-63 (7th Cir. 1960), *cert. denied*, 365 U.S. 812 (1961) (reliance on opinion of patent counsel that product is not infringing demonstrates good faith).

Many courts have held that faithful copying of a *patented* product shows an intentional disregard for the patent owner's rights and supports an award of increased damages under 35 U.S.C. § 284. *American Safety Table Co. v. Schreiber*, 415 F.2d 373, 378-79 (2d Cir. 1969); *Coleman v. Holly Mfg. Co., supra*, 269 F.2d at 666; *Saf-Gard Products, Inc. v. Service Parts, Inc.*, 370 F.Supp. 257, 272-73 (D. Ariz. 1974); *Hinde v. Hot Sulpher Springs, Colo.*, 359 F.Supp. 987 (D. Colo. 1972), *aff'd* 482 F.2d 829 (10th Cir. 1973); *Maxon Premix Burner Co. v. Mid-Continent Metal Products Co.*, 279 F.Supp. 164, 181 (N.D. Ill. 1967). Apparently only a few courts have been presented with the question of prepatent copying. In the cases relied

on by UBC, the courts either found that the patent was invalid, *see, e.g., Sears, Roebuck & Co. v. Stiffel Co., supra; Duplex Straw Dispenser Co. v. Harold Leonard & Co., supra;* or that there was no infringement, *see, e.g. Inject-O-Meter Mfg. Co. v. North Plains Fertilizer & Chemical, Inc., supra.* The courts thus did not reach the issue of willfulness, and the cases are distinguishable for this reason.

We hold Rixon's "faithful copying" of Milgo's modem, coupled with UBC's subsequent knowledge of the existence of the patent, continued sales, and absence of reliance on the advice of counsel, are sufficient to support the court's finding of willfulness in this case.

d. Attorney Fees

35 U.S.C.A. § 284 authorizes a trial court in patent infringement actions to award attorneys' fees to the party prevailing if the case qualifies as "exceptional".

> The court in exceptional cases may award reasonable attorney fees to the prevailing party.

The judge found that this case was "exceptional" within the statute, and awarded Milgo attorneys' fees in the amount of $250,000.00. An award of attorneys' fees, like an award of treble damages, is committed to the discretion of the trial court and may only be disturbed for abuse of discretion. *St. Regis Paper Co. v. Royal Industries,* 552 F.2d 309, 316 (9th Cir.), *cert. denied,* 434 U.S. 996 (1977); *Bolt Beranek & Newman, Inc. v. McDonnell Douglas Corp.,* 521 F.2d 338, 344 (8th Cir. 1975), *cert. denied,* 423 U.S. 1073 (1976); *Garrett Corp. v. American Safety Flight Systems, Inc.,* 502 F.2d 9 (5th Cir. 1974). Of course, the prevailing party has no right to attorneys' fees, and such an award must "be the exception and not the rule". *Q-Panel Co. v. Newfield,* 482 F.2d 210, 211 (10th Cir. 1973).

See also: Maloney-Crawford Tank Corp. v. Sauder Tank Co., supra.

UBC argues that this case is not "exceptional" because it did not assert sham or frivolous defenses. This argument is without merit. Assertion of a sham defense is not the only permissible basis for a finding that a patent case is "exceptional". A finding that infringement was willful and deliberate may justify an award of attorneys' fees to the plaintiff, as well as treble damages, depending on the circumstances of a particular case. *See Jen-Air Corp. v. Penn Ventilator Co.*, 394 F.Supp. 665 (E.D. Pa. 1975); *Saf-Gard Products, Inc. v. Service Parts, Inc., supra.* The trial court's award in this case has not been shown to be an abuse of discretion.

UBC further contends that, even if the case is "exceptional", there was insufficient evidence presented as to the nature of the fees incurred and their reasonableness. The trial court's award was apparently based on invoices of work performed by Milgo's counsel, Jackson & Jones Law Corporation, Tustin, California, from the commencement of the action in April, 1971 through November 7, 1977. The invoices were identified by testimony of Harold L. Jackson, a patent lawyer with that firm. The invoices totaled $269,653.75 plus $50,657.67 in expenses which included payments to local counsel. UBC argues that the descriptions of the work performed were obliterated by Milgo on the grounds of attorney-client privilege, and that therefore there is no indication that the amounts charged were reasonable.

It is the rule in patent infringement actions that "the grant of attorneys' fees is erroneous where *no* evidence is presented relative to the incurring or the reasonableness of the fees connected to the value of the services performed." *Maloney-Crawford Tank Corp. v. Sauder Tank Co., supra,* at p. 14. [Emphasis added]. Milgo argues that

the actual invoices submitted were the best evidence of its legal expenses, and that by failing to object or cross-examine during trial, UBC has waived its right to contest this issue now. The trial court took into account the length of time involved and the complexity of this litigation. The amount awarded is approximately $70,000 less than the total amount requested by Milgo. While additional evidence concerning the specific services rendered and testimony as to their reasonableness might have been helpful, the case should not be remanded for this purpose alone. *See American Safety Table Co. v. Schreiber, supra.* The trial court did not abuse its discretion with respect to the amount of the fees awarded.

e. Prejudgment Interest

35 U.S.C.A. § 284 affords the trial court discretion to award interest and costs to the plaintiff in addition to compensatory damages for patent infringement. UBC argues that the award of prejudgment interest in this case, which ran from the date of the last infringement, September 30, 1972, constituted an abuse of discretion since the damages were unliquidated.

As a general rule, interest may be awarded only from the date a claim is liquidated. *Dixie Cup Co. v. Paper Container Mfg. Co.*, 169 F.2d 645, 651 (7th Cir. 1948). In patent cases, however, the trial court has discretion under 35 U.S.C.A. § 284 to award interest from the date of the last infringement. *Georgia-Pacific Corp. v. U.S. Plywood-Champion Papers, Inc.*, 446 F.2d 295, 302 (2d Cir. 1971), *cert. denied*, 404 U.S. 870 (1971). The trial court's finding of willful and deliberate infringement provides a basis for an award of prejudgment interest. *Union Carbide Corp. v. Graver Tank & Mfg. Co., supra.* UBC has not made a sufficient showing that the trial court abused its discretion with respect to the award.

AFFIRMED.

JULY TERM - July 22, 1980

Before Honorable James E. Barrett, Honorable William E. Doyle and Honorable James K. Logan, Circuit Judges

---

No. 78-1624

MILGO ELECTRONIC CORPORATION, a Florida corporation,
Plaintiff-Appellee,

vs.

UNITED TELECOMMUNICATIONS, INC., a Kansas corporation,
Defendants,

UNITED BUSINESS COMMUNICATIONS, INC., a Kansas corporation,
Defendants-Appellants.

This matter comes on for consideration of the appellant's petition for rehearing and suggestion for rehearing en banc, filed in the captioned case.

Upon consideration whereof, the petition for rehearing is denied by the panel to whom the case was argued and submitted.

The petition for rehearing having been denied by the panel to whom the case was argued and submitted and no member of the panel or judge in regular active service on the Court having requested that the Court be polled on rehearing en banc, Rule 35, Federal Rules of Appellate Procedure, the suggestion for rehearing en banc is denied.

/s/ Howard K. Phillips
Howard K. Phillips, Clerk

IN THE
UNITED STATES DISTRICT COURT FOR THE
DISTRICT OF KANSAS

CIVIL ACTION KC-3380

MILGO ELECTRONIC CORP.,
Plaintiff,

vs.

UNITED TELECOMMUNICATIONS, INC., AND
UNITED BUSINESS COMMUNICATIONS, INC.,
Defendants.

FINDINGS OF FACT AND CONCLUSIONS OF LAW

(Filed January 13, 1976)

STATEMENT

This action was commenced on July 19, 1971, when plaintiff filed its original complaint (Doc. 1), alleging that it was brought under provisions of 35 U.S.C. §271 for infringement of its patent No. 3,524,023. Thereafter, and on September 25, 1972, plaintiff filed an amended complaint (Doc. 68), alleging infringement of the above patent and in addition, infringement of patents numbered 3,590,381 and 3,643,023. Relief sought by plaintiff is to determine liability of defendants for patent infringement and for costs, expenses, attorney fees and treble damages. The last item claimed because, as plaintiff contends, defendants willfully and wantonly infringed the plaintiff's described patents.

It is plaintiff's position that the three patents referred to cover inventions made by it or its assignors relating to new and novel data modem concepts. According to plaintiff, a modem is a telephone made specifically for a computer or an information terminal to communicate with another computer or terminal via an "ordinary" telephone line, i.e., a telephone line used for human voice communication. A standard telephone converts voice sound into an electric signal which is transmitted through the telephone wire and is converted back into sound at a receiving location to be heard by the ear of a listener. A modem, or data telephone, converts an output signal from a computer or a terminal into an electrical signal suitable for transmission through a telephone line, and at the other end it converts the received signal back to an information signal

of proper type to be understood by the computer or the terminal. The process of signal conversion and reconversion is called modulation and demodulation, and the word modem is a contraction (acronym) of "modulator-demodulator."

As used on connection with a modem, data is described as information, particularly that used as a basis for computer processing. For the purpose of discussion in conjunction with data transmission by a modem. data is a long string of two level (binary) signals which represents letters of the alphabet or numbers that are to be transmitted from one location to another remote location.

The record discloses that patent No. 3,524,023 is referred to as "Whang '023"; patent No. 3,643,023 is referred to as "Payne '023"; and patent No. 3,590,381 is referred to as "Ragsdale '381."

Summarizing plaintiff's contentions, it appears that one Rixon Electronics Corporation (Rixon I) was a competitor in the modem industry in 1968, that "Rixon modems" did not compete successfully with plaintiff's "Milgo 4400 modem series," and after failing in several attempts to produce a competitive modem, Rixon, referred in the record as Rixon I, procured a Milgo modem and slavishly copied the circuits used therein and thereafter utilized this information, thus acquired, in constructing, manufacturing and distributing on the market a modem labeled DS-4800 (PM-48A). Thereafter, in the fall of 1968, defendant United Telecommunications, Inc., (United) agreed to acquire Rixon I and its assets, and in the summer of 1969, all the assets of Rixon were transferred to Rixon Electronics, Inc., a new corporate entity, referred to as Rixon II. Thereafter, United formed another corporation, a wholly-owned subsidiary, known as United Business Communications, Inc. (UBC). The stock of Rixon II

was then transferred from United to UBC and in July, 1970, the marketing activities of Rixon II and the sales of its products, including the modems referred to as DS-4800 and DS-2400 series data sets, were transferred to UBC. Then in August, 1970, plaintiff's basic patent, the Whang '023 was issued. Plaintiff asserts that this patent was reviewed by defendants and personnel reported that the DS-4800 infringed plaintiff's patents, but UBC continued to manufacture and sell the DS-4800 and DS-2400 modems with the knowledge and approval of United. This, plaintiff claims, continued from July, 1970 to August, 1972.

Plaintiff contends that United's liability for infringement arises from the fact that United completely dominated and controlled the operations of both Rixon II and UBC. In addition, plaintiff contends that United is liable for infringement because it entered into a joint venture agreement with Sangamo Electric Company, Inc. (Sangamo), under the terms of which agreement United agreed to sell and transfer the infringing data sets to a new joint venture entity in which it would and did participate.

DEFENDANTS' CORPORATE ARRANGEMENTS

The response of defendants to plaintiff's claims requires an analysis of the somewhat complicated developments in the corporate arrangements conducted by United and its subsidiaries, as well as the other legal and factual defenses raised by both defendants. In connection with this phase of the case, the defendants contend that:

United is a corporation organized and existing under the laws of the State of Kansas. Prior to June 2, 1972, United operated under the name of United Utilities, Incorporated. United is and has at all times since November 15, 1938, been a holding company rather than an operating company and has at no time had operating divisions. Until

December, 1971, United was qualified to do business only in the State of Kansas. Since that time it has also been qualified in Pennsylvania for limited purposes.

United, as a holding company, owns the stock of a number of companies called the United Telephone System, as well as all or part of the stock of certain manufacturing, supply and service companies. It also has as other subsidiaries an electric, gas and water company, a computer time sharing company and a leasing company.

On or about October 24, 1968, an agreement in principle was entered into between Rixon Electronics, Inc., a Maryland corporation (hereinafter "Rixon I"), and United, contemplating the acquisition by a subsidiary to be formed by United of the business and assets of Rixon I in exchange for United stock. This was followed by an Agreement and Plan of Reorganization dated December 12, 1968, between United and Rixon I, whereby United agreed to issue to Rixon I shares of United's common stock in exchange for the conveyance by Rixon I of all of Rixon I's business and assets, less certain cash and marketable securities retained by Rixon I to satisfy expenses incidental to the contemplated transaction, to a newly organized wholly-owned subsidiary of United.

On May 23, 1969, United caused to be organized a Maryland corporation named New Rixelco, Inc. (hereinafter Rixon II) as a wholly-owned subsidiary. On July 3, 1969, United issued to Rixon I 597,105 shares of its common stock, and Rixon I transferred and conveyed to New Rixelco, Inc. (Rixon II) all of its business and assets (including, without limitation, its patents and permits), except certain cash and marketable securities retained by Rixon I to satisfy expenses incidental to the contemplated transaction, and New Rixelco, Inc. (Rixon II) assumed all of the liabilities and obligations of Rixon I then existing,

except Rixon I's expenses relating to the transaction and certain outstanding stock options of Rixon I under its employees stock option plans, which options were assumed by United.

Subsequent to July 3, 1969, the name of Rixon I was changed to Rixon Liquidating Company, and the name of New Rixelco, Inc. (Rixon II) was changed to Rixon Electronics, Inc. on July 11, 1969. Rixon Liquidating Company (Rixon I) has continued in operation since that time as an independent company totally unrelated to United or any of its subsidiaries.

UBC was organized as a Kansas corporation on January 5, 1970. UBC was organized to enter the business of selling, engineering, installing and servicing private voice and data communications equipment, services and systems for sale or lease to business users. On June 24, 1970, United transferred to UBC all of the outstanding stock of Rixon II, and Rixon II was at all times thereafter a wholly-owned subsidiary of UBC. Beginning in July, 1970, UBC undertook the marketing of certain products of Rixon II (formerly New Rixelco, Inc.), including the modems charged by plaintiff as infringing plaintiff's patents. On January 1, 1972, by agreement of the officers of UBC and Rixon II, UBC discontinued the marketing of data modems and Rixon II assumed responsibility for providing its own marketing, both non-government and government. The UBC inventory of data modems (including DS-4800 and DS-2400) and other products were earmarked for Rixon II, withdrawals from the inventory and payment to UBC thereafter being made as Rixon II consummated sales to third parties. UBC discontinued the marketing of data modems of the type here involved, including specifically the DS-4800 and DS-2400, as of January 1, 1972, and has made no sales of such modems since that date.

United and UBC first learned that plaintiff was claiming infringement of the Whang '023 patent when they were served with process in this action in July, 1971.

The infringement charge in the original complaint was based upon the contention by Milgo that a 4800 bit per second (bps) data modem being sold by UBC came within the scope of one or more claims of the Whang '023 patent, UBC was charged with infringement by reason of its sale of the data modem. United was charged with making and selling the allegedly infringing data modems.

The 4800 bps data modems sold by UBC were sold by it under its trade designation DS-4800. The data modems were manufactured by Rixon II. At the time of commencement of the suit, Rixon II was a Maryland corporation and a wholly-owned subsidiary of UBC. Neither Rixon I nor Rixon II were at the outset of the suit or have been since named as a party.

Neither United nor UBC ever controlled or exercised any dominion over Rixon I (now Rixon Liquidating Company, Inc.), either before or after Rixon I transferred its assets to Rixon II in July, 1969.

Between the time of the organization of Rixon II in May, 1969, and the organization of UBC on January 5, 1970, the stock of Rixon II was wholly-owned by United. Since January 5, 1970, the stock of Rixon II has been wholly-owned by UBC. However, on or about October 1, 1972, pursuant to an agreement dated as of September 29, 1972, by and between Sangamo Electric Company, United, Rixon II, and UBC, Rixon II conveyed substantially all of its assets and business to a newly formed corporation, Rixon, Inc., a Delaware corporation (hereinafter Rixon III). Rixon III was formed and has since operated as a subsidiary of Sangamo Electric Company, which owns

60% of the equity and has the option to purchase United's 40% interest under certain conditions. Since on or about October 1, 1972, Rixon II has not engaged in the manufacture, sale, or use of any of the alleged infringing devices.

VALIDITY OF PATENTS QUESTIONED AND INFRINGEMENT DENIED

Defendants deny that the 4800 bps (bits per second) modems sold by UBC under designation DS-4800 incorporated the disclosed circuitry of the Whang '023 patent, the Ragsdale '381 patent or the Payne '023 patent. Defendants also deny that the 2400 bps modems sold by UBC under designation DS-2400 incorporated the disclosed circuitry of the Ragsdale '023 patent. They assert that plaintiff does not claim the DS-2400 infringes Whang '023 or Ragsdale '381. Defendants deny that the DS-4800 and DS-2400 modems were "slavishly copied" from the plaintiff's Milgo 4400 series data modems nor from any of plaintiff's patents.

Defendants contend that the issue of infringement must be decided on comparison of the patents with the accused equipment and not devices commercially offered and sold by or on behalf of the patentee, it being defendants' claim that none of the claims of the Whang '023 patent are properly readable on the DS-4800 modems sold by UBC or by any data transmission systems sold by UBC. Defendants also insist that Whang '023 is a "paper patent" and was not used in the Milgo 4400 allegedly copied by Rixon. Furthermore, defendants say that the pertinent claims in Whang '023 patent are invalid and void because the subject matter of the claims were known and publicly disclosed in the art prior to Whang's alleged invention of such subject matter and the differences, if any, claimed

and the prior art as a whole would have been obvious to a person having ordinary skill in the art, and in any event if the claims in the Whang '023 patent are interpreted broadly enough to read upon defendants' DS-4800 sold by UBC, then these claims are broader than any invention to which Whang might otherwise have been entitled and are not properly based or supported by disclosure in his application.

Defendant also claims the Whang '023 patent is invalid and unenforceable by reason of being based on an inadequate disclosure, that the claims are not made in clear, concise and exact terms.

Defendants say that the claims of Ragsdale '381 patent are not readable on DS-4800 modems sold by UBC. Also, that the claims of Ragsdale '381 patent are invalid and void on the grounds of public disclosure in prior art on the subject matter and the differences claimed were obvious to a person having ordinary skill in the art, and any claims made in Ragsdale '381 interpreted broadly enough to read upon DS-4800 are broader than any invention to which Ragsdale might be entitled. Again, defendants say that if the claims of Ragsdale '381 are so broadly interpreted, then they are not based upon or supported by the disclosure of the application filed in the Patent Office.

Defendants allege that UBC has not sold any DS-4800 modems which include a digital detector as represented in Rixon drawing 540-1112B, and none of the claims of Payne-Ragsdale '023 are readable on any data transmission systems sold by UBC. It is again alleged by defendants that the Payne '023 (Ragsdale, et al, '023) patent is invalid and void because the subject matter of the claims had been known and publicly disclosed in the art prior to the alleged invention, and the differences, if any, in the subject matter as a whole would have been obvious to

a person having ordinary skill in the art at the time and further that if the patent is interpreted broadly enough to read upon DS-4800 data modems sold by UBC, or any system on which modems are employed, they are broader than any invention plaintiff might otherwise have been entitled to in its original application. It is also asserted that if the claims are interpreted to include within their scope the DS-4800 data modems of UBC, then they are broader than and not properly based upon or supported by disclosure of the application for the patent, and none of the claims in this patent are readable on DS-2400 modems sold by UBC.

Defendants further contend that any of the identified claims of Ragsdale, et al, '023 (Payne '023), if interpreted broadly enough to read upon the DS-2400 data modems sold by UBC, or any system in which modems are employed, they are broader than any invention to which the Ragsdale, et al, '023 might otherwise have been entitled in its originally filed application and if the claims are interpreted to include within their scope the DS-2400 data modems of UBC, then they are broader than and not based upon or supported by the disclosure of the application originally filed.

Defendants also claim that UBC discontinued selling data modems as of January, 1972, and has not and could not have infringed the Ragsdale, et al, '023 patent as that patent did not issue until February 17, 1972.

PRETRIAL PROCEDURE

A review of the file discloses that a conference was held January 24, 1973. The Magistrate prepared a memorandum of the conference (Doc. 84). Each party was directed to state in writing the party's factual contentions and the issues of law and fact. Plaintiff's statement is

Document 106. The statement of defendants is Document 109. The Magistrate made a brief summary of the claims and contentions of the parties and entered a pretrial order, Document 125, which reads in pertinent part:

> "Briefly, plaintiff claims that the defendants wilfully infringed three of plaintiff's patents, copies of which are attached to the Amended Complaint (file document No. 68). Plaintiff claims that Rixon, the manufacturer of the claimed infringing products, and United Business Communications, Inc., are mere in-instrumentalities of United Telecommunications, Inc.; Defendants deny these contentions, and attack the validity of the patents.
>
> "Highly summarized, the issues are whether Rixon and United Business Communications, Inc. are mere instrumentalities of United Telecommunications, Inc.; whether the patents in suit, and the specific claims of each, are valid; whether the various claims of plaintiff's three patents are infringed by the manufacture and sale of the DS-2400 and DS-4800 Data Sets; whether defendants actively induced infringement of those claims; whether the infringement was willful; and the nature and extent of plaintiff's damages.
>
> "The parties agree that the question of damages shall not be tried until the other question of law and fact have been determined. The parties do not agree upon trial of the issues of willfulness. Defendants contend that the question of willfulness of the alleged infringement should be tried as a part of the damage issue, if and when that is tried. Plaintiff contends that defendants' acts of deliberate and willful infringement including the copying activities of Rixon are pertinent to the trial on the issue of liability as well as to the award of attorneys fees.

"There is no question as to jurisdiction or venue. Trial will be to the court at Kansas City, Kansas.

. . .

"File documents No. 106 and No. 109, being the statements of the factual contentions and the issues advanced by the respective parties, are made a part of the pretrial order."

COMMENT

After hearing the evidence offered by the parties, the Court requested the parties to submit proposed findings of fact and conclusions of law. They have complied. Likewise, well prepared briefs have been filed and oral arguments were afforded counsel.

The Court has reviewed the files, the extensive notes kept during trial and at all subsequent proceedings. A transcript of the evidence has been provided and numerous exhibits have been supplied for the Court's consideration. The Court has read the depositions received in evidence and which were not read at trial, also the communications from counsel following the oral arguments. In addition, the Court has studied the material supplied by the Federal Judicial Center included in the volume entitled "Seminars for Newly Appointed United States District Judges," including the "Kettering Award Address" by Judge Giles S. Rich entitled "The Vague Concept of Invention as Replaced by Sec. 103 of the 1952 Patent Act," at page 564; also, Judge Rich's speech at page 600 of the same volume in which he discusses "Infringement Under Section 271 of the Patent Act of 1952"; and the discussion entitled "The Varied Meanings of 'Invention' in Patent Practice: Different Meanings in Different Situations," page 24. While I can no longer claim to be "newly appointed," the discussions have been helpful in considering the legal problems

involved in this litigation. I have found the comments of Judge Howard T. Markey, Chief Judge of the Court of Customs and Patent Appeals, reported at 66 F.R.D. 529, to be very instructive as they relate to some of the issues raised in this case.

I have also carefully read the case of *Price v. Lake Supply,* 510 F.2d 388 (10th Cir.), in which that court in some detail considered the sufficiency of the trial court's findings and of particular interest was the following declaration at 394:

> "The trial court held that although the accused device was not precisely identical, nevertheless the two devices do the same work in substantially the same way, accomplishing substantially the same result.
>
> "In *McCullough* this court recognized that a patent which constitutes a marked improvement in the art is entitled to a substantial range of equivalents, and every element or its functional equivalent must be found in the accused device in order to have an infringement.
>
> "Consistent with *McCullough* and the other decisions, we agree with the trial court that the presence of the nuts and bolts rather than the pivot does not result in the accused device being outside the range of equivalents. It would seem that since the loosening of the nuts and bolts and the removal of the strap and headers accomplishes the same result as the pivot, the obviousness of this change brings the accused device within the scope of the equivalent doctrine."

The Court further pointed out that whether there is infringement and applicability of equivalents are both factual questions.

The Tenth Circuit analyzes the *Graham-John Deere* case in an opinion found in *Halliburton v. Dow Chemical Co.*, 514 F.2d 377, where the court said at 379:

> "Graham v. John Deere Co., 383 U.S. 1, 17-18, 86 S.Ct. 684, 15 L.Ed.2d 545, mentions three basic factual inquiries essential to a determination of obviousness. They are (1) scope and content of the prior act, (2) differences between the prior art and the claims at issue, and (3) level of ordinary skill in the pertinent art. Each of these was considered and, on substantial evidence, resolved against Dow. John Deere also states three secondary considerations, (1) commercial success, (2) long felt but unresolved needs, and (3) failure of others. Dow relies on these secondary considerations. The need for consideration of secondary evidence is 'an evidentiary question primarily entrusted to the district court.' Potter Instrument Company, Inc., 1 Cir., 499 F.2d 209, 211. Lack of invention cannot be outweighed by secondary factors. Dow Chemical Co. v. Halliburton Oil Well Cementing Co., 324 U.S. 320, 330, 65 S.Ct. 647, 89 L.Ed. 973."

Another Tenth Circuit case dealing with patent infringement and having some application here is *Swanson v. Unarco*, 479 F.2d 664, where at 670, Judge Pickett's opinion in an earlier case is approved as follows:

> "Infringement is not avoided by making a machine which differs in form but appropriates the principle and mode of operation of the patented machine by the use of the same or equivalent means. . . . Infringement exists if the accused device performs substantially the same function in substantially the same way and accomplishes substantially the same result as the patented device, even though they differ in name, form and shape. . . . If the accused machine falls clearly

and definitely within the claim of a patent, infringement is made out. McCullough Tool Co. v. Well Surveys, Inc., supra. The protection provisions of a patent cannot be avoided by adding materials unless a wholly different result is obtained. 'Colorable differences without substance do not avoid infringement.' Bewal, Inc. v. Minnesota Mining and Mfg. Co., [10 Cir.], supra 292 F.2d 159 at 167."

There are several fundamental rules that the Court must consider in attempting to arrive at a just disposition of the issues in this case which present some difficult questions of fact, the resolution of which must be based on evidence not easily comprehensible to one lacking the technical training of the experts who offer the testimony on which the issues must be settled.

We begin with the proposition that a patent is presumed to be valid and that the burden of proof is on the party asserting invalidity and the burden of proof is a heavy one and invalidity must be established by clear and convincing evidence. 35 U.S.C. §282; *A. E. Staley Co. v. Harvest Brand*, 452 F.2d 735, 736.

Where all elements of an invention were known in the prior art but not utilized together, if the combination produces unexpected results different from the prior art, an invention may be patentable, particularly where the prior art indicates that the procedure utilized by the patent will be unproductive. *U.S. v. Adams*, 383 U.S. 39.

In considering the validity of the separate patents, each must be considered individually in the context of the prior art and not in the context of the other. Under the statute, 35 U.S.C. §121, the claims of the three patents in the suit must be considered with respect to each other in the same manner as one considers the claims of a single

patent with respect to each other. See *Illinois Tool v. Foster Grant*, 395 F.Supp. 234, 256.

Under patent law, no doctrine is better established than that a prior patent or publication, to be an anticipation, must bear within its four corners adequate directions for the practice of the patented invention. The test of obviousness must be applied in the context of the circumstances that existed when the challenged invention was made and not in the context of today's technology. 35 U.S.C. §103; See 395 F.Supp. 234, 257.

While 35 U.S.C. §112 compels full disclosure for an inventor to obtain the monopoly grant, shorthand descriptions, if understandable by those skilled in the art, are acceptable under this rule of reason. *Columbia Broadcasting v. Zenith Radio*, 391 F.Supp. 780, 791.

Disclosure of a claimed invention is performed not only by the claims made but by the patent specifications and accompanying drawings, which elucidate the claims. 35 U.S.C. §112. The test of disclosure of claimed invention is only that one skilled in the art must be able to ascertain the invention without undue experimentation. Furthermore, there is no requirement that the drawings accompanying a patent be so detailed as to be production specifications. 35 U.S.C. §§112, 113; *McClaren v. B-I-W Group, Inc.*, 401 F.Supp. 283, 293, 294.

An inventor may be his own lexicographer. The function of the claims is to define the scope of the invention; is is not their function to describe the embodiment. Claims are legal definitions, not descriptions. Disclosure is further performed by the patent specification and accompanying drawings which may elucidate the claims of the patent. *McClaren v. B-I-W Group*, supra, at 294.

Anticipation is a technical defense and unless all of the same elements are found in exactly the same situation and united in the same way to perform the identical function in a single prior art reference, there is no anticipation. *McCullough Tool Co. v. Well Surveys, Inc.*, 343 F.2d 381.

Infringement of patent is established when patent owner demonstrates that alleged infringer has made, used, or sold a product, process or apparatus coming within the scope of the claimed inventions. *W. R. Grace v. Park Mfg.*, 378 F.Supp. 976, 978. The true test of infringement is whether the accused device and the device covered by the patent do the same work in substantially the same way to accomplish substantially the same result. *McCullough Tool Co. v. Well Surveys*, supra, at 401.

In a suit for patent infringement, the plaintiff has the burden of proving its case by the preponderance of the evidence. 69 C.J.S. *Patents*, §325, p. 984.

A patent must be a valid one in order to support a claim of infringement thereof, and there can be no infringement of a patent before it is issued. 69 C.J.S. *Patents*, §283, p. 843; *American Bottle v. Orange Crush*, 76 F.2d 969 (4th Cir.).

While the grant of a patent creates a presumption of validity the presumption is rebuttable. The ultimate question of validity is one of law for the Court to decide. The burden of establishing invalidity of a patent rests upon the party asserting it and one who relies on anticipation to defeat patentability must sustain that anticipation by clear and convincing proof. *Consolidated Elec. v. Midwestern*, 260 F.2d 811 (10th Cir.).

The motive or intent with which an alleged act of infringement is committed is immaterial, and a person may

infringe a patent without an actual knowledge of its existence. 69 C.J.S. *Patents*, §285, p. 844.

Patent infringement is committed by one who makes, uses or sells a patented invention without authority, or by one who actively induces infringement. 35 U.S.C. §271; *Scaramucci v. FMC Corp.*, 258 F.Supp. 598 (Okla.).

The test of infringement is whether the patented device and accused device do the same work in substantially the same way and accomplish substantially the same result. Impairment of function and lessening of result, in degree only, does not avoid infringement. *Williams Iron Works v. Hughes*, 109 F.2d 500.

The claims of a patent are interpreted in the light of the specifications, but with reference also to its file-wrapper history. A claim in a patent must be read and interpreted with reference to claims that have been canceled or rejected and claims allowed cannot by construction be read to cover what has thus been eliminated from the patent. *Schriber v. Cleveland Trust*, 311 U.S. 211.

Where a defendant shows use or disclosure by others before the application, the burden is no longer on defendant to establish that plaintiff was not the first inventor and the burden shifts to the patentee to show prior invention. *Thompson v. American Tobacco Co.*, 174 F.2d 773; *American Lakes v. Nekoosa Co.*, 83 F.2d 847.

On the question of what constitutes new matter in an amendment to an application for patent, the opinion of the examiner is to be given great weight and an amendment made more than one year after the invention went on sale does not disqualify applicant where the amendment was clarifying in its form and effect rather than new matter. *Price v. Lake Supply Sales*, 510 F.2d 388 (10th Cir.).

Where evidence shows that others had tried and failed to solve the problem presented and evidence shows that the problem was solved—this answers an attack that the patent was obvious. *Panduit Corp. v. Burndy Corp.*, 378 F.Supp. 775.

For patented subject matter to go against teaching of prior art is indication of non-obviousness thereof. *W. R. Grace Co. v. Park Mfg. Co.*, 378 F.Supp. 976.

Defendants urge the applciation of the holding of the Supreme Court in the case of *Muncie Gear v. Outboard Marine*, 315 U.S. 759, and contend that plaintiff is disqualified for a patent under Whang '023 because his invention was offered for sale and was in use in excess of one year prior to the date of the patent application. Specifically, defendants claim that the application as originally filed did not disclose center sampling at the center of modulation periods and the amendment filed March 29, 1968, was the first disclosure of this claim and was more than one year after the invention was offered for sale and used.

The Tenth Circuit has had occasion to interpret the *Muncie Gear* decision. In *Price v. Lake Sales Supply*, supra, that court made the following pertinent observations which this Court believes to be a correct and proper application of *Muncie Gear*, at 393:

> "Appellee Price made the initial application less than a year after the invention went on sale. But the time of the amendment was more than one year after the invention went on sale. Appellant contends that the *Muncie Gear* rule recognized, however, that where the amendment 'only makes express what would have been regarded as the equivalent of earlier claims or where it merely incorporates into one claim [that

which could] be gathered from the perusual of all, if read together, it [must] be allowed.' Autogiro Company of America v. United States, 384 F.2d 391, 410 (Ct.Cl.1967). If, on the other hand, the amendment is something more than a clarification, *Muncie Gear* applies. See Monroe Auto Equip. Co. v. Heckethorn Mfg. & Supply Co., 332 F.2d 406 (6th Cir. 1964), which says 'the question is whether there is anything in the prior disclosures which will support the subsequent claim, or does the claim broaden or change the original invention.' Id. 332 F.2d at 417.

"The trial court considered the amendment not to be in conflict with the rule of *Muncie Gear*. The Examiner reached the same conclusion. The opinion of the Examiner (and that of the court too) is to be given great weight in determining what is 'new matter.' See Technicon Instruments Corp. v. Coleman Instruments Corp., 385 F.2d 391 (7th Cir. 1967). The question is, of course, a factual evaluation. To us also the amendment is clarifying in its form and effect rather than new matter."

That interpretation is applicable to the situation here.

CREDIBILITY OF WITNESSES

Defendants' counsel question the competency of plaintiff's witness Robert Ragsdale on the basis of an objection raised by plaintiff's attorney when Ragsdale's deposition was being taken by defendants in Washington, D.C., on December 15, 1972. The objection was that Ragsdale was "not qualified for comparison of claim language to products." At that time Ragsdale indicated that this was true. However, three years later, as a witness, Ragsdale demonstrated substantial ability to make physical comparison

of the involved modem and data processing equipment from a practical engineering standpoint.

Defendants produced as an expert witness Dr. Walter R. Beam. His credentials were impressive. He undertook to cover every technical point raised by the defendants in their efforts to counter and neutralize the force of the claims which had been allowed in the patents involved. It appears that his opinions were theoretical and based on data designed to support them rather than from a study of the applicances involved in the litigation and their practical operation. Such effort to support every point raised by defendants and his failure to study and observe the operations of the patented articles and those alleged to infringe impaired the weight of his testimony as the Court considered it.

FINDINGS OF FACT
ON
GENERAL ISSUES OF VALIDITY AND INFRINGEMENT OF PLAINTIFF'S PATENTS

1. This is an action under Title 35 U.S.C. §271 for infringement of U.S. Letters Patent Nos. 3,524,023 (PX 1); 3,643,023 (PX 2); and 3,590,381 (PX 3). The original Complaint in this action was filed on July 19, 1971, and alleged infringement of U.S. Patent 3,524,023. An amended Complaint, filed by leave of court on September 25, 1972, alleges infringement of all three of the patents in suit.

2. There are three patents involved in this suit—Patent No. 3,524,023, issued August 11, 1970, naming Sang Y. Whang as inventor and titled "BAND LIMITED TELEPHONE LINE DATA COMMUNICATIONS SYSTEM" (hereinafter the "Whang '023 patent"); Patent No. 3,590,381, issued June 29, 1971, naming Robert G. Rags-

dale as inventor and titled "DIGITAL DIFFERENTIAL ANGLE DEMOCULATOR" (hereinafter the "Ragsdale '381 patent"); Patent No. 3,643,023, issued February 15, 1972, naming Robert G. Ragsdale and Paul E. Payne as inventors and titled "DIFFERENTIAL PHASE MODULATOR AND DEMODULATOR UTILIZING RELATIVE PHASE DIFFERENCES AT THE CENTER OF THE MODULATION PERIODS" (hereinafter the "Payne '023 patent").

3. Plaintiff, Milgo Electronic Corporation (hereinafter "Milgo"), is a Florida corporation having its principal place of business at 8600 N.W. 41st Street, Miami, Florida. Milgo is the owner of the three patents in suit and has the right to sue for infringement thereof.

4. United Business Communications, Inc. (hereinafter "UBC"), was organized as a Kansas corporation on January 5, 1970. UBC was organized to enter the business of selling, engineering, installing and servicing private voice and data communications equipment, services and systems for sale or lease to business users and at a time pertinent to this action has been a wholly-owned subsidiary of United Telecommunications, Inc. (hereinafter "United").

5. Defendant, United, is a Kansas corporation organized and operating under the laws of Kansas with its principal place of business at 2330 Johnson Drive, Shawnee Mission, Kansas. At the time of filing of this Complaint, United's name was United Utilities, Incorporated. On or about June 2, 1972, United changed its name to United Telecommunications, Inc.

6. Rixon Electronics I and II (hereinafter referred to as Rixon I until July 3, 1969, and as Rixon II after July 3, 1969 until the fall of 1972) (R. 2175, 2225) at times pertinent to this action were Maryland corporations having their principal place of business at 2120 Industrial

Parkway, Silver Springs, Maryland. Neither Rixon I nor II is a party to this suit. Rixon I did not actually manufacture the accused modems but initiated the engineering project of building a modem (R. 2211), which project resulted initially in the PM-48 modems and later in the DS-4800 modem. Rixon II has manufactured, sold and serviced modems variously designated as DS-4800 and DS-2400.

7. All three patents deal in one way or another with the transmission of binary data ("1's" and "0's") over telephone lines and with the implementation of or alleged improvements in equipment for sending and receiving the binary information. Equipment for this purpose is generally known by the designation "modem" (from modulator-demodulator) or, alternatively, "data set."

8. United, in the fall of 1968, entered into an agreement in principle to purchase Rixon I and the assets were formally transferred to a new United subsidiary, Rixon II on July 3, 1969. In the fall of 1972, the assets of Rixon II were sold to Sangamo Electric Company, and defendants have stipulated that such assets include at least one each of the modems Model Nos. DS-4800 and DS-2400 (PX 70 and 71).

9. A modem, considered in this case, is a communication device that allows a computer or information terminal to communicate with another computer or information terminal via ordinary unconditioned voice-grade telephone lines that are used for everyday human voice telephone communication. A data (information) signal from a terminal is converted into an electrical signal which is suitable for telephone line transmission and at the other end the received signal is reconverted back to an original data (information) signal. The signal conversion and reconver-

sion by the modem is accomplished by modulation and demodulation, and the word modem is a contraction (acronym) of *mod*ulator-*dem*odulator (R. 91-93; R. 162-165).

10. A Glossary of Terms (PX 107) defines various technical terms which are pertinent to this action and the definitions thereof have been testified to by the inventors of the patents in suit and have been agreed to (with some minor modifications) by the defendants' technical expert (R. 162-282; R. 1041-1083). The definitions of the technical terms in PX 107 are hereby adopted and incorporated, as modified (See Appendix A), in the findings of fact hereof to the extent necessary for explaining the technical terms of these findings of fact. (PX and DX as used herein refer to plaintiff's and defendants' trial exhibits respectively. Where the exhibits include more than one page, the exhibit number will be followed by page number.)

11. In approximately 1964, the commercial usage of ordinary voice-grade telephone lines to interconnect terminals and computer systems via modems began to increase. The increase was brought about in part by the introduction of the IBM 360 computer. As computer usage increased, an expanded need was developed to allow users to employ modems to transmit data over ordinary voice-grade telephone lines between interconnected terminals and remote computers. The commercial-based computer system concept has stimulated the need for modems capable of transmitting data at high speed rates over "ordinary" voice-grade telephone lines (R. 94-97).

12. The "ordinary" telephone line which was originally developed for human voice has a bandwidth of about 300 to 3000 Hz, which bandwidth although suitable for

human voice transmission presents numerous signal impairments to data transmission. The modem industry employs such "ordinary" voice-grade telephone lines for the purpose of transmitting data. Such telephone lines come in two categories, namely switched voice-grade telephone lines and leased voice-grade telephone lines (R. 216-222; R. 225, 226).

13. A switched voice-grade telephone line is the telephone line obtained when telephone calls are made using regular dial or push button telephones. The cost for the switched voice-grade telephone line is based on actual usage on per connection basis. Since the connection is accomplished by automatic switches in a first available shortest path basis, the telephone line characteristics of a switched voice-grade telephone line may change each time a new path is established even though the same number is reached each time a call is placed (R. 216-222).

14. Leased voice-grade telephone lines are hand selected by telephone company engineers to make a fixed connection between two remote points for the duration of the lease. Since a leased voice-grade telephone is not expected to change its characteristics during the term of the lease, it is possible to correct some of the undesirable characteristics on the leased line to make the leased line a better line for purposes of data transmission (R. 216-222).

15. Switched lines utilized for human voice communications are more difficult to employ for data transmission purposes than leased lines. In addition, the leased lines which are graded as 4-A and 4-B are of a "poorer" quality as compared to grade 4-C which is a more expensive and more precisely conditioned leased line. As such, the poorer quality leased lines of grade 4-A and 4-B are the more difficult leased lines for data transmission purposes (R. 216-222).

16. The largest and most prominent factor in the modem industry for many years prior to the early 1960's was Western Electric Manufacturing Company, an arm of the Bell Telephone system. In the early 1960's, the leading independent modem manufacturers included Rixon and Collins. Milgo did not enter the commercial modem market until mid-1967, when it was a newcomer in competition with the largest independents that included at that time Rixon, Collins and Lenkurt (R. 116-118).

17. In 1965, Western Union was in the process of completing construction of a voice and data transmission facility which it termed its broadband exchange network, shortened to BEX network. The BEX network had switching centers located at various metropolitan locations throughout the United States and was operated much like a conventional telephone network in the sense that connections from point to point were dialed up through the switching centers in random paths. The network was developed primarily for data transmission and in conjunction with this aspect of use, Western Union was a potential customer for modems or data sets (R. 333-340).

18. At that time there was a need for a data modem which could satisfactorily transmit 2400 bits of data over switched telephone lines. Prior to 1966, Western Union Telephone and Telegraph Company had a modem of its own design which would satisfactorily transmit 1200 bps over its switched or BEX network but did not have any modem of its own design which would satisfactorily transmit 2400 bps over the BEX switched network (R. 115, 332, 333).

19. In about 1965, Western Union Telephone and Telegraph Company discontinued further efforts to create its own modems and initiated an evaluation of the modems

then commercially available (R. 348-351). The evaluation program sought to locate a modem which could satisfactorily transmit 2400 bps over the Western Union BEX switched network (R. 347, 348).

20. Late in 1965 (November and December) Milgo called upon Western Union with the thought in mind of interesting Western Union in purchasing modems for Milgo. The particular unit that Milgo had in mind for sale at that time was a unit which Milgo had put together from its previous experience in missile range tracking and similar endeavors. It was a frequency shift keyed unit operating at an odd bit rate and required a relatively wide band for operation, described as around 1800 to 2000 Hz. Western Union was not interested in the Milgo unit. However, during the course of meeting with Milgo personnel (including Mr. Whang), Western Union indicated that it would be interested in a modem that would process 2400 bits per second and in which the bandwidth required for operation would be less than 1000 Hz, with the 1000 Hz band centered at 1700 to 1800 Hz (R. 365A-366; 468-469).

21. Western Union had been challenging modem manufacturers to provide a modem for their BEX network which would operate satisfactorily at 2400 bps using less than 1000 Hz of bandwidth. Western Union had concluded that if the modem operated within that bandwidth it could successfully transmit 2400 bps through the BEX switched network. The challenge was contrary to the theory of the day. Western Union issued the challenge to Sang Whang of Milgo (R. 366-367).

22. After receiving the Western Union challenge in about November, 1965, Whang returned to Milgo (R. 318). Whang was not at that time an experienced modem de-

signer (R. 323), but did have knowledge of the characteristics of telephone lines gained by his earlier professional experience in designing filters for operation in conjunction with telephone lines (R. 153, 154). Based on his experience with telephone lines, Whang concluded that most telephone lines would "look" alike and the noise factors of switched telephone lines would not be severe if a modem employed a very narrow bandwidth of less than 1000 cycles, provided the bandwidth was centered about a center frequency of between 1600 and 1800 Hz (Whang '023 patent, Col. 2, lines 38-43, R. 757, 767, 768, 929, 1000, and 1001).

23. In December, 1965, Whang developed a modem which, for 2400 bps operation, employed differential eight phase modulation of a single carrier centered at 1700 Hz and double sideband operation. It used a narrow bandwidth which limited the spectrum of single energy outside of the requisite narrow bandwidth to negligible values so as to stay within the 1000 cycle or less specification and make all lines within that bandwidth appear similar (Whang '023 patent, Col. 2, lines 38-43, Col. 3, lines 40-53, R. 768, 777, 779, 882, 929, 935, 937, 1000, 1001).

24. Whang built a composite filter means in his original modem which limited the data modulated carrier signal to a frequency range of between 800 and 1000 Hz. The combination of multi-level (eight phase) and narrow bandwidth filtering in a data modem at the time of the invention of the Whang '023 patent was contrary to the then existing practices employed in the modem industry (R. 235, 1010 and R. 369-372, 387, 501). Such a combination creates severe problems in recovery of data, recovery of clock for sampling, and increases the sensitivity of the system to signal impairments presented by telephone lines over which data is to be transmitted (R. 935). At the time of his original conception, Whang was not aware of how

he would recover a clock signal required for demodulation at the center of the modulation period in his modem (R. 784).

25. While the original modem was being constructed, Whang discovered that the narrow band limiting feature of the Whang '023 patent in suit yielded a carrier envelope of a unique shape at the receiver. Whang was about to obtain a precise clocking signal from the unique shape of the carrier envelope (R. 784-788). The original Whang modem was the first to employ narrow band limiting in a phase modulated system in order to obtain a carrier envelope from which a derived clock may be obtained. The Whang clock recovery was a new technique that was significantly different from the standards used in modems at that time (R. 325-327; and R. 399, 402, 465).

26. As Whang's original modem was being built, it many times did not operate satisfactorily. His own engineers and co-employees, who knew more about modems than Whang, presented literature to Whang suggesting that his modem concept was not technically feasible. Whang persisted in his original modem concept, and ultimately the Whang '023 invention was incorporated in the first commercially acceptable modem that was capable of transmitting 2400 bps over ordinary switched voice-grade telephone lines. The original Milgo modem was designated Milgo modem Model 4400/24 (R. 119; R. 322, 329; and R. 407, 408, 413, R. 329, 489).

27. In about June, 1966, Whang advised Western Union that he had successfully designed a feasibility model of the Milgo 4400/24 modem which would allow Western Union to meet their customer's requirements of 2400 bps transmission over the BEX network (R. 329, R. 368, 369).

28. The prototype modems were examined by Western Union and were demonstrated to Western Union personnel as early as June, 1966 (R. 369; PX6; PX 7) and were tested prior to November, 1966 (R. 427). Mr. Spilling testified that bandpass filter in the transmitter was quite narrow (R. 428-429). Also, the transitions of the clock were precisely coincidental with the center of the modulation period, and again, according to Mr. Spilling, this was extremely important to an eight phase modem (R. 461; DX J-2).

29. The selection by Western Union of the particular 1000 Hz portion of the voice band in the BEX network, which it described to Milgo, was based on analysis by Western Union of line transmission characteristics of the BEX network. Western Union had determined that this particular channel in the voiceband was the most stable for data transmission in that its characteristics were the most predictable on the average, even though random selection of lines through switching operations was carried out. As stated by Mr. Spilling, who testified at trial, the 1000 Hz band, centered at 1700 to 1800 cycles, was that part of the voiceband that appeared to look nearly alike from one network to the other or from one connection to the other (R. 468-469).

30. In November of 1966, Milgo and Western Union entered into a contract of sale for the modems developed by Milgo, the amount of the contract being approximately $600,000.

31. According to Western Union scientists, prior to the Milgo 4400/24 modem, there was no commercially available modem which would transmit 2400 bps satisfactorily over the BEX switched network. The Milgo modem which incorporated the principles of the Whang invention

was so contrary to the then existing state of the art that Western Union's scientists at first did not believe that the Milgo modem could satisfactorily transmit 2400 bps over switched telephone lines in a bandwidth of less than 1000 Hz (R. 368, 369). According to Western Union, the Milgo 4400/24 modem was the first practical eight phase modem (R. 369-372).

32. Prior to the Whang '023 invention, the modem industry believed that the modem that performs the best with greatest noise tolerance margin over a good line or without a line (back-to-back) would also perform the best over a poor line. For that reason, most prior art modems employed wide band energy spectrum and two or four level modulation (R. 935, 938, DX F-1; R. 2345-2354, DX G-1, DX J-1, DX I-1, DX T-1, DX L-2, PX 29/10, PX 179).

33. The Whang '023 invention made a breakthrough because Whang approached the problem with a completely opposite philosophy. His approach was based on the theory that a modem that would perform the best and adequately over a lousy line would perform adequately over any line (Whang '023, Col. 2, lines 38-43). Whang's invention combined both eight level modulation and extreme band limiting into one modem. The Whang approach represented a new and novel conceptual theory that went against the state of the then existing modem art (R. 369-372; R. 395).

34. The facts set forth in Finding No. 29 are borne out by Western Union's evaluation and comparison test results shown in pages 4, 5 and 6 of PX 10. The tests show that the Milgo 4400/24 modem exhibited poorer performance in operation over good telephone lines than either the Bell or Lenkurt modems. However, over narrow part of telephone lines, the Milgo 4400/24 modem per-

formed satisfatorily, whereas the Bell and Lenkurt modems did not do so. Milgo's 4400/24 modem performed about the same regardless of the type of circuit over which the modem was operating (PX 10, R. 357-363; R. 374-385; R. 501).

35. The Milgo modems Model 4400/24, purchased by Western Union, were labeled as Western Union 2247A modems. These Milgo modems allowed Western Union to offer a reliable nationwide 2400 bps service over the BEX network and thereby opened up new customers to Western Union, and reduced operating costs (R. 389-392, 413). The narrow bandwidth of the Milgo modem 4400/24 also allowed Western Union to place additional information in the form of a secondary channel on the lower end of the spectrum of ordinary voice-grade telephone lines (R. 447-449). In addition, the restricted bandwidth made equalization requirements less stringent than in the broad bandwidth prior art modems (R. 2142, 2143). The original Milgo modems 4400/24 did not require variable equalization, but rather operated satisfactorily with a statistical equalizer (R. 281). Milgo's null meter technique of equalization made equalization easy to even non-skilled users (R. 624-625; R. 883-886).

36. Both Western Union and Milgo management were convinced that the Whang '023 invention as incorporated in the Milgo modem 4400/24 and the corresponding Western Union 2247A modems were major breakthroughs in the data transmission art (R. 480-482; R. 666). It was acknowledged that the Whang '023 invention filled a need which had existed for a long time in that it allowed economical communication between computers or terminals over inexpensive switched voice-grade telephone lines. Defendants' own technical expert conceded that the principles of the Whang 4400/24 modem were contrary to the mo-

dem practices existing in 1966 (R. 2156) and the Milgo modem 4400/24 was a great help to Western Union and it solved a problem that Western Union couldn't solve (R. 2145).

37. Milgo, based on the success of the 4400/24, applied the principles of the 4400/24 (eight phase and narrow band limiting) into a 4800 bps modem referred to as Milgo's 4400/48. The first Milgo 4400/48 included the type of analog detectors used in the Milgo 4400/24. Although satisfactory in operation, the analog detectors were causing Milgo reproducibility problems (R. 393-396; R. 1035-1039, 1112).

38. Milgo Model 4400/48 was the first modem to successfully transmit 4800 bps over the poor quality 4-A and 4-B leased telephone lines (R. 119-121; R. 666). It was recognized as an immediate commercial success. Sale of the Milgo Model 4400 series increased from about $1,000,000 in 1968 to $4,400,000 in 1969 and $5,500,000 in 1970. In 1970, the competing DS-4800 modem was marketed by Rixon. Milgo sales of its 4400 series dropped from about $5,500,000 in 1970 to about $2,700,000 for 1971 and 1972 (PX 18, page 2).

39. Subsequent introduction of additional modem series by Milgo (Models 4600, 3300, 2200, 24/LSI and 20/LSI as well as the 4400 series embody the claimed inventions of the patents in suit (R. 800, 823, 824; R. 1112, 1121-1131, PX 18). The patented Milgo modems are today sold on a worldwide basis (R. 715-717). In less than a decade from its entry into the modem market, Milgo/ICC has emerged as one of the acknowledged leaders of the independent modem manufacturers (R. 120, 121). The growth of Milgo today is attributable to the patented modems, and the success of the patented modems in the

marketplace is not attributed to advertising which has maintained a constant budget from the period of 1968 to date of approximately 2% to 3% of sales (R. 696, 697).

40. Total modem sales for the modems by Milgo have risen from about $4,000,000 in 1967 to $11,600,000 in 1972; $14,500,000 in 1973; $16,500,000 in 1974; and approximately $17,000,000 annualized for the Milgo fiscal year ended September 30, 1975 (PX 18, R. 669-682). Royalties under Milgo's inventions, including the inventions of the patents in suit, have resulted in royalties paid to Milgo in the order of approximately $56,000 in 1970; $89,000 in 1971; $84,000 in 1972; $181,000 in 1973; $170,000 in 1974; and about $190,000 annualized for 1975 (R. 714-715). The sale of modems has completely turned Milgo around from a loss position in 1966 to a very profitable corporation today (R. 682).

41. Claim 19 of Whang '023 provides for a data transmission system having a transmitting and receiving device connectable together by a signal transmission link, said system comprising:

> means for storing a group of at least three serial bits inputted to said transmitting device at a given data bit rate;
>
> means at the transmitting device for generating a carrier signal having a given modulation period and modulated with all of the digital bits of said group to be transmitted over said link during said modulation period;
>
> means at the transmitting device for applying the data modulated signals to the signal transmission link;
>
> means at the receiving device operative for sampling each modulation period at substantially the

center thereof and responsive thereto for demodulating the data modulated signals received over said link; and

filter means connected in the signal transmission link between said modulating and demodulating means, the filter means being characterized as having a passband width of about 1/T Hz and having a center frequency of fo selected between 1500 Hz and 1800 Hz, and a passband substantially equal to 1/3 the data bit rate; where:

T is the modulation period, fo is the carrier signal frequency, and Hz is cycles per second.

42. Claim 20 is dependent on claim 19 and adds to the subject matter of claim 19 the limitations that the modulating means is a phase differential system with the phases selected in 45° multiples, that the demodulating means includes means for sampling the phase angle of the carrier signals during the center portion of each modulation period, and that the system also includes means for comparing the phase angles so as to restore the transmitted digital data levels to the original format.

43. Claims 21 and 22 relate to further definition of the transmission link between the transmitting and receiving devices. Claim 21 establishes that the filter means and the transmission link form a composite filter network having substantially a linear phase and constant amplitude and delay characteristics. Claim 22 defines the transmission link to be a randomly selected telephone line having matched characteristics over a selected narrow band width.

44. Claim 25 is similar to claim 19, but is directed specifically to phase differential modulation and is not limited to grouping the bits in groups of three. It does,

however, include the sampling of the phase angle of the adjacent signals during the center portion of the modulation period, and also sets forth the filter means in the terms of having a passband width of about 1/T Hz.

45. Claims 27, 28 and 29 are all dependent on claim 25 and recite further limitations with respect to the filter means, particularly, with reference to where the filter is located, i.e., at the transmitter or receiver. Claims 31 and 32 are like claims 21 and 22, described above. Claims 36 and 37 are also dependent upon claim 25 and add to claim 25 the presence of a clock recovery circuit based on reception at the receiver of a band limited carrier envelope and utilizing a 1/T signal component derived from envelope to control a clock signal generator.

46. The findings require a somewhat detailed review of the course that the application which resulted in the Whang '023 Patent followed during its pendency in the Patent Office and of the commercial activities of the plaintiff during the years 1966-1967.

47. The file wrapper of the Whang '023 Patent is in evidence as DX A. The claims submitted with the application as filed are found at pages 39-48 of the file wrapper. One purpose of band limiting was to reduce the bandwidth to a bandwidth in which the delay and attenuating characteristics of the randomly selected telephone lines were sufficiently predictable as to do away with the need for variable equalization. The claims as filed were not limited only to phase modulation, but included also amplitude and frequency modulation.

48. At the end of March, 1968, before any action had been taken by the Patent Office, and after a change in patent attorneys by the applicant, an amendment was filed in which all of the claims originally submitted were

canceled (DX A, pp. 63-67). Twenty-seven new claims (claims 29-55) were substituted. These claims did define "center sampling" either at the center of the modulation period, or during the center of the modulation period (DX A, pp. 64 & 68). The word "only" was added to this claim on page 64 of DX A by later amendment.

49. The twenty-seven claims submitted with the March, 1968 amendment were rejected by the Examiner in an Action dated July 19, 1968 (DX A, pp. 78-82). They were rejected both on the basis of an inadequate disclosure and on the ground that they defined nothing patentable over a Baker patent No. 3,128,343 (DX L-2) and an article by Irland (DX M-2) published in October, 1958. The Baker patent was relied upon by the Examiner to show a phase modulated data transmission system producing phase shifts in a 1750 Hz carrier and in which the modulated wave is demodulated by comparing the incoming phase with the preceding phase, as in the Whang arrangement. Irland was relied upon for disclosing a filter in a data transmission system limited to 800 Hz along with an equalizing circuit.

50. The inadequate disclosure rejection was based in part on the fact that the pulse produced by the clock circuit for sampling the produce modulators would be 625 microseconds long, which did not accord with a modulation period of 1250 microseconds.

51. A further amendment was filed on October 30, 968 (DX A, p. 85 et seq.). This was more than two years after the application had been filed. In this amendment the specification was amended to add to it a statement defining sampling of the product modulators as taking place "for a short time duration only at the middle of the modulation period." (DX A, p. 86). The attorney

noted in his remarks accompanying the amendment (DX A, pp. 92-95) that:

> "The specification has been amended to improve its form and to achieve conformance with the drawings and claims as originally filed. By separate letter to the Patent Office Draftsman, gates 67-70 of Figure 12 have been shown and labeled as 'Sample and Hold' gates. In Fig. 13 the gates 67-70, previously repeated from Fig. 12, have been deleted. Drawing changes were suggested in the Office Action, and such changes conform the drawing to applicant's disclosure at page 29, lines 29 and 30. Applicant's attorney appreciates the Examiner's courtesy in calling this and certain other discrepancies to his attention.
>
> "An Abstract has been added. Certain clarifications in the specification are believed to fully traverse the objections to the specification. In particular answer to certain objections, it is noted that:
>
> "(1) Timing recovery at the receiver, it is submitted, is fully described at page 17, lines 2 through 19, and again starting at line 26, page 25, and continuing through line 28, page 26. As stated, the input wave of Fig. 9(e), as a result of applicant's narrow band limiting filter, includes strong 800 Hz energy which is synchronized with the modulation rate of the transmitter. After the envelope of Fig. 9(e) is full wave rectified, it is passed through an 800 Hz center frequency narrow band filter 56 which isolates out the 800 Hz signal. The output of filter 56 has a frequency which is synchronized with the modulation rate. Any suitably stable oscillator circuit 57 may then be synchronously driven by the output signal from filter 56.

"(2) In the Office Action reference was made to the pulse width of an 800 Hz clock. The 800 Hz clock employed at the receiver is not a symmetrical square wave, but rather is a narrow pulse which is repetitive at the center of each modulation period, i.e. 800 times per second. Applicant's severe band limiting assures phase integrity (i.e. output like input) only at the middle third of each modulation period. Thus, sampling is done at the middle of each modulation period for a time period in the order of 5 to 10 microseconds. The sample is 'held' by gates 67-70 for approximately 1,250 mocroseconds.

"(3) A gate 107, in view of the above, is held 'on' for the sample and hold duration by an output from one of gates 104, Fig. 15. The 2400 Hz clock is passed by the enabled gate 107 to shift out a decoded pattern from register 108. See page 30, lines 1-19.

"(4) In the Office Action reference was made to ring counter 23 which changes state in response to pulse from encoder 20. Only one 'one' circulates in ring counter 23 and thus only one phase at a time is outputted. During a transition and for an extremely short duration more than one phase may be outputted in the manner noted in the Office Action, but its effect is negligible.

"(5) The question posed as to why a fixed equalizer need not be adjusted, may best be answered in connection with a short summary of applicant's invention since it is closely related to one key feature, thereof.

"Prior to the advent of this invention, it was commonplace to attempt equalization over a major portion of the full spectrum of standard telephone lines, i.e. between 1,000 and 2,600 Hz. See for example the

right hand column, middle section of page 378 in the Ireland Paper cited in the Office Action. Although it was recognized that the best transmission portion of a given sampling of standard telephone lines was between 1,200 and 2,200 Hz, no one prior to applicant took advantage of this known fact by narrowly band limiting the signals to match this optimum portion of all standard telephone lines. In applicant's invention the digital signals to be transmitted are modulated on a carrier signal which is selected at the center of the optimum transmission portion of such telephone lines. The pass band of applicant's filter is severely bandlimited to the inverse of the modulation period expressed in cycles per second. By letting the line characteristics dictate applicant's signal format, applicant's carrier frequency may be selected in the range from 1600 Hz to 1800 Hz provided that the bandwidth is limited to no more than about $\pm$ 500 Hz on either side of the selected carrier frequency. Neither Baker nor Ireland, nor any other known reference employs this novel principle as presently claimed by applicant.

"Phase modulation is particularly useful in applicant's invention in either eight or four-phase formats. With an eight-phase format the passband is limited to 1/3 the bit rate. Typical examples of these passbands with a center frequency of about 1700 Hz are given in applicant's specification for 1200 BPS, 2400 BPS and 4800 BPS modems.

"With the foregoing in mind, it may be seen that applicant has rejected signal components outside of his narrow bandwidth. In the prior art, components outside the bandwidth coming through at the wrong times with irregular amplitudes produce a distorted

signal, such as that shown in applicant's Fig. 6. However, applicant's filter to reject such unnecessary components introduces its own delay distortion to the system. Such delay, however, is simply compensated for by a fixed equalizer, or delay correcting network. Applicant's fixed equalizer also compensates for average delay and amplitude variations for standard telephone lines only within the narrow bandwidth, all telephone lines now 'look' alike over the narrow bandwidth in question."

Provision for sampling done at the middle of each modulation time period in the order of 5 to 10 microseconds does not appear in the application as filed nor the patent as issued.

52. On October 30, 1968 application claims 57, 58, 59 and 60 were submitted to the Patent Office (DX A, 89-90). These claims were respectively re-numbered as application claims 58, 59, 60 and 61 by a Supplemental Amendment dated November 1, 1968 (DX A, 101).

The claimed elements of these claims were adequately described in the specification and claims as originally filed in the application (DX A, 4-55) and also as claimed by claims 29, 30, 35, 36 which were submitted by the Amendment dated March 29, 1968 (DX A, 63-66).

Re-numbered application claims 59, 60 and 61 include the elements of issued patent claims 20, 21 and 22. These claims are dependent claims; and the claim from which they were dependent (claim 58) was objected to by the Examiner "as being unclear" (DX A, 109) in an Office Action dated February 14, 1969. Claim 58 was canceled and rewritten as application claim 79 which ultimately issued (with minor typographical correction) as inde-

pendent claim 19 in suit. Application claim 80 was filed in an Amendment dated March 29, 1969.

It likewise finds adequate support in the specification and claims as originally filed. Application claim 80 issued as claim 25 in suit.

53. On November 1, 1968, a further amendment in the application was filed in which certain earlier claims presented were canceled and rewritten and others were amended. This amendment (DX A, pp. 101-107) was filed subsequent to an interview with the Examiner at which the applicant Mr. Whang and his attorney were present. In this amendment, the concept of center sampling was included in the claims. Including the claims which were added by the amendment, there now appeared in the application a total of approximately 45 claims.

54. The primary claims of the Whang '023 patent asserted in this litigation, namely claims 19 and 25, on which all the other claims asserted are dependent, include in substance the claims previously made in claims bearing other numbers. In this amendment of March 27, 1969 (DX A, pp. 111-117) application claim 79 (became claim 19 of the patent, and application claim 80 became patent claim 25.

55. As set forth in Finding 32, prior art modems employed wideband energy spectrum and two or four level modulation. They required a special line conditioning to insure the adequate performance of the modem. And, as set forth in Findings 23, 24, 25 and 32, Whang's invention combined both eight level modulation and extreme band limiting into one modem to adapt the modem to the lousy line. No prior art modems or references ever taught the industry to use only a small narrow part of the line so that within that part all the lines look alike and dependable.

56. Typical of the state of the prior art is the Bell 201 modem series and comparable modems provided by other manufacturers. Such Bell-type modems are described in the Baker patent (DX H-3), the Logan patent (PX 179), the Baker paper (DX I-1) and the Bennett & Davey textbook (DX J-1). Such Bell-type modems employ four phases and require a wide energy spectrum from 600 to 3000 Hz for 2400 bps (DX I01, page 116, Col. 3; R. 2337-2340; 2348-2355). The wide energy spectrum is employed to recover a clock signal (PX 179). It is conceded that if the composite filter disclosed and claimed in the Whang '023 patent were inserted in the Bell-type modems, such modems could not derive a clock signal (R. 1435, R. 2150). The Whang '023 patent in suit as claimed is awarded a presumption of validity over the Bell-type modems which were described in the Baker and Logan patents considered in detail by the Patent Office in connection with the examination and issuance of the Whang '023 patent (DX A). The claimed features of the Whang '023 patent represent significant and non-obvious improvement over the Bell-type modems and the following exhibits: DX H-3, PX 179, DX I-1, and DX J-1.

57. Another type of modem, representing the state of the prior art, employs vestigial sideband amplitude modulation. Such prior art includes the Rixon Sebit series as described in Myrick (DX B-1) and the Irland reference (DX M-2) (cited by the Patent Office in the Whang '023 patent) and the article by Brand and Carter (DX T-1). The Sebit series are described in an article by Hollis (DX F-1) and by the Myrick patent (DX B-1). Hollis was then President of Rixon, and his paper describes that a vestigial sideband two level amplitude modulation is preferred over four phase differential modulation of the type employed in the Bell modems. Hollis says that if the bandwidth is narrowed, the data rate must be reduced.

Any technical person considering the Rixon Sebit products and the Hollis article would conclude that it was contrary to those teachings to develop an eight phase modem of the Whang '023 patent (DX F-1). Irland's paper (DX M-2) describes a similar vestigial sideband system operating at 1600 bps rate. For that speed, the operation requires special line correction between 1000 and 2600 Hz (DX M-2, Col. 2, p. 378) and is thus a typical example of adapting the line to insure the performance. The Whang '023 teaching is contrary to the teaching by Irland. The paper by Brand and Carter (DX T-1) describes another vestigial sideband system operating at 1650 bps rate. The paper specifies that "the requirements established for the local line are that, over the effective band from 700 to 2600 bps, the attenuation shall be flat within $\pm$ 1 db and the envelope delay within $\pm$ 100 ms." Thus, a wideband system requiring special line requirements is described (DX T-1, p. 657, right hand column). The Whang '023 patent in suit is awarded a presumption of validity over the vestigial sideband type modems described in the Irland paper which was considered by the Patent Office in connection with the examination and issuance of the Whang '023 patent (R. 2364-2368). The claimed features of the Whang '023 patent represent significant and non-obvious improvements over the defendants' exhibits DX B-1, DX M-2, DX T-1, and DX F-1.

58. The prior art Kaenel patent (DX X-2) describes the use of amplitude modulation in addition to phase modulation. The phase modulation carries data and the additional amplitude modulation is employed to derive a clock signal. Since Kaenel does not suggest narrow band limiting of the Whang '023 patent, Kaenel required additional amplitude modulation to recover the clock. Furthermore,

the Kaenel patent has amplitude modulation of a frequency of 1/2T, whereas the Whang invention as claimed has envelope variations created by the narrow band limiting of a frequency of 1/T (R. 2374). The claimed features of the Whang '023 patent represent significant and non-obvious improvements over the defendants' exhibit DX X-2.

59. The paper by Toeffler and Buterbaugh (DX G-1) describes a four phase modem by Hughes, the HC-270 modem. The reference does not teach the extreme band limiting nor employment of the dependable part of the line. In the absence of extreme band limiting, the clock derived will lose its accuracy when operating over a poor line. The Whang '023 clock is derived using the energy only in a very narrow band; therefore, it does not lose accuracy over a wide variety of lines. The claimed features of the Whang '023 patent represent significant and non-obvious improvements over defendants' exhibit DX G-1.

60. The defendants introduced into evidence defendants' J-1 which is a book entitled DATA TRANSMISSION, written by William R. Bennett and James R. Davey, heads respectively of the Data Theory Department and Data Terminals and Transmission Department of Bell Telephone Laboratories, Incorporated. This defendants' exhibit is acknowledged as a so-called "Bible" for data communications teachings (R. 778, 779) and was characterized by defendants' technical expert Dr. Beam as a repertorium of data transmission techniques listing in one spot the work, theoretical and experimental, over a good many years of the Bell Telephone Laboratories and others (R. 1482). Exhibit J-1 describes the modem developments in existence in 1965 for the Bell Company and numerous other modem manufacturers such as Collins, Rixon, Lenkurt, Lincoln Laboratories, Hughes, Robershaw-Fulton and

others (J-1, pp. 247-251). Dr. Beam, referring to page 227 of J-1, originally asserted that one who had been supplied with the Western Union criteria, would be led to a differentially phase modulated modem grouping three bits together for eight phase modulation and that it would be obvious to employ a Nyquist bandwidth of 1/T Hz or about 800 cycles and that it would also be obvious to select a carrier frequency of 1700 Hz in order to stay within the criteria suggested by Western Union (R. 1557-1568). On cross-examination, Dr. Beam admitted that he had neglected to read certain portions of pages 227 and 228 of DX J-1 which clearly teaches two different types of modem operation which also would meet the Western Union specifications with an even better signal-to-noise ratio than a differentially phase modulated modem. These other modem operations include vestigial sideband and quadrature amplitude modulation systems, both with suppressed carrier and coherent detection. Thus, DX J-1 as admitted by Dr. Beam, teaches away from the invention of the Whang '023 patent (R. 2014, 2067-2078). The features of the Whang '023 patent represent significant and non-obvious improvements over the teachings present in DX J-1.

61. Dr. Beam testified that DX J-1 taught the optimum bandwidth for a phase modulated modem to be any bandwidth expressed as 100%, 50%, or anywhere down to zero (R. 2059). Optimum cannot represent an infinite number of values, and Whang testified that optimum filtering considerations for a phase modulation system (as stated in pages 209, 98, Fig. 7-3 and page 56, Fig. 5-11 of DX J-1) meant 100% roll-off or about twice the bandwidth claimed by Whang. The Whang invention teaches and claims his composite filter means which, when expressed mathematically in terms of roll-off of DX J-1, requires a roll-off

of from about 50% roll-off down to the ideal or zero percent roll-off of the 1/T Nyquist limit (R. 2337-2345). The features of a narrowband composite "filter means" of the Whang '023 patent represents a significant and non-obvious improvement over the widebandwidth filters recommended for phase modulated systems in DX J-1.

62. The features of the Whang '023 patent represent significant and non-obvious improvements of the state of the prior art represented by Western Union's own modern designs, and the modem techniques of the existing prior art modems evaluated and compared by Western Union (R. 369-372; R. 395).

63. The Payne '023 patent led Ragsdale to the development of the Ragsdale '381 digital coherent detection patent (R. 1109-1117). The digital detector of the Ragsdale '381 patent accomplished phase locking of two signals of different frequencies in a restricted bandwidth modem in spite of the presence of repeated phase shifts in the same direction as acknowledged by defendants' expert Dr. Beam (R. 2086). Originally, Dr. Beam asserted that the Kawai patent (DX Z) and Lender patent (DX A-1) showed the method of deriving a reference carrier for coherent detection. However, Dr. Beam finally admitted that phase locking two such sinusoidal signals of different frequencies was a difficult task (R. 2066), and further admitted that he knew of no prior art that did what Ragsdale did in the '381 patent and that included all the technical things that Dr. Beam could think of (R. 2087). Defendants' own technical expert admitted that the Ragsdale '381 patent distinguishes over the prior art he was aware of, and the claimed features of the Ragsdale '381 patent represents significant and non-obvious improvements over all prior art known by defendants' technical expert.

64. The Bennett & Davey textbook (DX J-1) represents the state of the art that existed prior to the invention date of the Ragsdale '381 patent. That textbook at page 258 taught that it was "impossible" to do what Ragsdale did in his '381 patent. The claimed features of the Ragsdale '381 patent represent significant and non-obvious improvements and is a major advance over the state of the art as set forth in the textbook DX J-1 (R. 2086-2089).

65. The defendants attempted to reconstruct the principles of the Payne '023 and Ragsdale '381 patents from a paper by Wilson (DX I-2). The Wilson paper includes a box labeled "computer" where there could be almost anything, including a general purpose computer (R. 2041, 2042, 2046, 2047). Dr. Beam admitted that even a general purpose computer in Wilson would have to be modified to accomplish the principles of the Payne '023 and Ragsdale '381 patents (R. 2046-2048). The circuits of the Payne '023 and Ragsdale '381 patents were admitted by Dr. Beam as being novel over the functions of the general purpose computer of Wilson (R. 2048-2054). The Payne '023 and Ragsdale '381 patents define features which represent significant and non-obvious improvements over DX I-2.

66. The defendants' expert Dr. Beam relied on the Chomicki patent (DX X-1) in an attempt to show a comparison between phase locking of Chomicki and odd-multiple phase locking in the Ragsdale '381 patent. The Ragsdale '381 coherent detector is phase locked to the squared I.F. so that the zero crossing of the squared I.F., at pre-selected center sample times, will occur at an odd multiple of one-half of the modulation angle increment. An output lead from the 22.5° state of the Ragsdale '381 binary counter is connected in the phase lock loop. At the zero crossing time of the incoming I.F. during a pre-selected center sample interval the state of that 22.5° output is

employed by the loop to either add 2.8° or subtract 2.8° from the counter depending upon whether the 22.5° counter stage is in a "zero" or a "one" state at that sample time (R. 1109, 1110, 1111 and SUMMARY OF THE INVENTION, Ragsdale '381 patent, Col. 2, lines 10-13). This causes the phase angle outputs of the counter (which are compared to obtain the phase shifts between successive modulation periods) to be accurately related to the sampled portion of the received I.F. As a result, coherent detection or measurement is made each modulation period by the Ragsdale '381 detector.

66a. The foregoing features of responding to the zero crossings of an incoming I.F. at pre-selected center sample times allows the Ragsdale '381 detector for the first time to (a) operate successfully with repeated phase shifts in a restricted bandwidth system, which phase shifts cause an apparent frequency change in the carrier when received at the receiver, and (b) frequencies, i.e., the 20.9 KHz I.F. and the frequency shifted carrier. Neither Chomicki nor any other reference (including Kawai or Lender) can successfully operate with repeated phase shifts in a restricted bandwidth system that requires phase locking two different frequencies together. None of the references have a phase lock loop responsive to a pre-selected sample time and a zero crossing of an I.F. during that sample time as claimed in the Ragsdale '381 patent. According to Dr. Beam, none of the prior art could ". . . phase lock in a restricted bandwidth system with repeated 90-degree phase shifts, except the Ragsdale '381 patent . . ." (R. 3087).

66b. The Chomicki patent does not teach a coherent detector but discloses, instead, a ". . . circuit for adjusting of timing of a coded data receiver . . ." (Col. 1, lines 34-35 of Chomicki). The phase locked loop of the Chomicki

patent is used to locate a bit period and to generate a sample signal which is not "pre-determined" nor is it at the center of a modulation period; but rather Chomicki generates sample pulses either at the end of the first quarter of the bit period or at the end of the third quarter of the bit period. As disclosed by Chomicki at ". . . Figs. 2 and 3, (wherein) the line sample is effected . . . at the end of the first quarter of the bit period while in Fig. 4 the sampe is effected . . . at the end of the third quarter of the bit period . . ." (Col. 6, lines 17-23). The line signal of Chomicki is a bi-phase type of signal that is used to record data for tape transports (R. 2441). It is not a modulated carrier signal which is converted at the receiver to an I.F. or high frequency signal as is true in the Ragsdale '381 patent. Chomicki samples the polarity of a bi-phase signal at two different bit periods to determine whether the received bit is a "one" or a "zero" (Col. 5, line 60 of Chomicki patent), and thus does not sample the phase of a received signal, nor does it lock the data containing portion of a received carrier signal to an odd multiple of the value of an output phase (a reference signal) at a predetermined portion of each suggested modulation period. The only relevance of Chomicki to the Ragsdale '381 patent would be that Chomicki's circuit, once it was phase locked, could be employed as a clock and timing control 120 as shown in Fig. 2 of the Ragsdale '381 patent (R. 2441). The defendants have failed to meet their burden of proof in citing any prior art which is more relevant to the Ragsdale '381 patent than that cited by the Patent Office, and have not rebutted the presumption of validity of the Ragsdale '381 patent.

67. The Payne '023 and Ragsdale '381 patents define and claim digital detectors. The defendants referred to a paper describing an HC-270 modem by Hughes (DX

G-1) as having some portions of the circuits digitized, but Dr. Beam admitted that the detector described in DX G-1 is an analog detector (R. 1573, 1576) rather than a digital detector. In a similar manner, the detectors of the Kawai patent (DX Z) and the Lender patent (DX A-1) are also analog detectors (R. 1890, 2091, 2092).

68. Analog detectors such as those disclosed by DX G-1, DX Z and DX A-1, suffer from many problems associated with analog detectors, which problems as testified to by Ragsdale, were overcome by the digital detectors of the Payne '023 and Ragsdale '381 patents (R. 1035-1039, 1112; R. 2438, 2439). The digital detectors of the Payne '023 and Ragsdale '381 patents represent significant and non-obvious improvements over the analog detector of the HC-270 described in DX G-1, and over the analog detectors of DX Z and DX A-1.

69. Ragsdale testified that none of the defendants' exhibits that Dr. Beam referenced taught or suggested the claimed features of the Payne '023 or the Ragsdale '381 patents (R. 2442). None of the references introduced by the defendants teach or suggest the significant improvements over the prior art that are provided by the claimed features of the Payne '023 and Ragsdale '381 patents (R. 2442). The defendants have not cited any prior art that is any more pertinent to the Payne '023 or Ragsdale '381 patents than that cited by the Patent Office in the prosecution and issuance of the Payne '023 and Ragsdale '381 patents (DX B and DX C).

70. All of the patents testified to by Dr. Beam with reference to the three patents in suit were present either in the file histories of the three patents in suit or were present in the classes and sub-classes (PX 168, 169) which were searched by the Patent Office Examiners in conjunction with the prosecution and issuance of the three patents

in suit. The defendants did not introduce any prior art having teachings that rebut the presumption of validity which is awarded in patents in suit upon their issuance by the U. S. Patent Office (PX 168 and 169, R. 1690-1692).

71. Defendants failed to prove that the inventors in filing the applications which issued into the patents in suit did not meet all of the requirements of 35 U.S.C. §§ 102, 103, 111, 112, and 115.

72. The Whang '023 patent, in the last means clause of claim 25 states:

> "filter means connected in the signal transmission link between said modulating and demodulating means, the filter means being characterized as having a passband width of about 1/T Hz, and having a center frequency of fo; where:
>
> T is the modulation period,
>
> fo is the carrier signal frequency, and
>
> Hz is cycles per second."

Claim 19 includes a similar filter means clause with the additional definition that three bits (eight levels) are grouped together for 4800 bps modulation, and that the filter means is further characterized by having a center frequency "selected between 1600 Hz and 1800 Hz and a passband substantially equal to 1/3 the data bit rate."

73. Sang Whang wrote most of his own patent specification (R. 2361) without the benefit of some of the existing textbooks, such as Bennett & Davey (DX J-1) (R. 2307). Whang defined the term used in his claims "passband width" of a filter in a manner different from conconventional definitions for filters as they appear in the textbook. The Bennett & Davey textbook defines bandwidth as being the Nyquist band, and will, therefore, in-

clude filters with many different roll-off characteristics such as 100%, 50% to zero percent. The Bennett & Davey textbook uses the term roll-off to specify energy bandwidth limits. A 50% roll-off or less is required to define the narrow band filter means (composite filter) of the Whang '023 patent claims.

74. The filter means of the Whang patent must limit the energy spectrum as close as practical to the so-called Nyquist band (e.g., 800 Hz for 2400 bps and 1600 Hz for 4800 bps) in order to use the minimum telephone bandwidth for transmitting signal energy. Whang in his patent teaches that for a 2400 bps modem where 1/T =800 Hz, the signal energy passed by the filter means should not exceed 1000 Hz (Whang '023 patent, Col. 16, lines 17-24) and that for a 4800 bps modem where T =1600 Hz, the signal energy passed by the filter means should not exceed 2000 Hz (R. 778; R. 2317, 2318).

75. The term passband width of about 1/T Hz as used in the Whang '023 patent defines a filter which passes signals having frequencies within the passband of 1/T Hz, i.e., 800 or 1600 Hz, and rejects within a few percent all signals having frequencies more than 25% of the passband, i.e., 800 to 1000 Hz and 1600 to 2000 Hz (R. 2317-2319).

76. It is only when the Bennett & Davey definition of filter bandwidth is used in reading claims 19 and 25 of the Whang '023 patent that such claims may be read on a 100% roll-off filter (R. 2402-2403). When these claims are read with the inventor's definition of filter passband width, as set out in the patent specification, the claims are limited to a composite filter with a much smaller roll-off characteristic (50% or less), which filter will pass a narrow band of signal frequencies as compared to a

wideband 100% roll-off filter. Only then is one following the teachings of the Whang '023 patent as claimed (R. 2403, 2411, 3513).

77. While both parties in this action differ about the proper interpretation of "center-sampling" as disclosed in the original specification, the drawing of Fig. 12 of the original application depicted a sampling operation which took place at the center of the modulation period (R. 985, 986, 989). The defendants have failed to meet their burden of proof that the drawings as originally filed do not teach and disclose a center sampling operation.

The evidence establishes that:

(a) the original specification teaches that the phase angle of the carrier should be sampled ". . . in the middle of the modulation period (or) * * * at the center of each modulation period (where) the phase angle . . . is substantially identical between the generated wave and received wave * * * (and that) the phase information integrity of the received signal is maintained only around the middle third of the modulation period . . . ." (DX A, pp. 8-9, 18, 19);

(b) the drawings of the application as filed teach an apparatus (Fig. 12), which in fact samples the phase angle of the carrier at the center of each modulation period with an extremely short sampling interval (R. 985, 986, 989); and

(c) the Examiner in the Patent Office, an expert in this field, accepted the adequacy of the original specification and drawings as supporting the claims in issue including center sampling (DX A, pp. 108-110, 118).

This is not a case where applicant broadened or changed his claimed invention as set forth in the original application by an Amendment filed at a later time. The original claims such as 6 and 11 cover the infringing modems as well as the Milgo 4400 series modems which were sold to Western Union and others. Such original claims covered a phase modulated narrow bandwidth modem with phase shift detectors at the receiver without any limitation as to what portion of the modulation period was sampled, e.g., center or ends. While the original application and drawings disclose that one must sample in the middle or center portion of the modulation period because of the narrow band limiting, the original claims were not limited to a demodulator which sampled at the center.

The Examiner, in an Office Action dated July 19, 1966, questioned the operation of the multipliers and sample and hold gates of the detector disclosed and described in the original Whang application, and notes that "If gates 67-70 are sample and hold gates and not AND gates, an illustration of such gate should be given." In an Amendment filed October 10, 1968, the specification was amended to improve its form and to achieve conformance of the drawings and claims with the specification as originally filed. Gates 67-70 of Fig. 12 were redrawn and were labeled as "sample and hold gates." In Fig. 15, gates 67-70 were repetitious and such gates were deleted from Fig. 15. The questions raised by the Examiner concerning the timing at the receiver were answered by the applicant in his Amendment. The Examiner entered the above-noted Amendment, removed his previous inadequate disclosure rejection, and did not further question center-sampling at the receiver, nor the operation of sample and hold gates in the Whang application (DX A, pp. 108-110, 118). No new matter was added to the Whang applica-

tion by the above-noted or any other Amendment filed during the prosecution of the Whang '023 application.

The patent Examiner handling the Whang '023 application was well aware of his responsibility pursuant to 35 U.S.C. §132, not to allow any amendments which introduced "new matter" into the application because in the Office Action dated July 19, 1966, he rejected certain application claims (39, 53 and 54) covering features not involved in this litigation. These claims were rejected as being "drawn to new matter." The Examiner repeated his rejection based on new matter in an Office Action dated February 14, 1968, and those claims were deleted before the notice of allowance of the Whang '023 patent was issued from the Patent Office.

78. Since the filing of the original application on July 14, 1966, the written specification of the Whang '023 patent application sufficiently disclosed the subject matter defined by the claims in issue. The written specification and drawings of the original Whang '023 application have at all times amply supported the claims in issue of the Whang '023 patent. The Patent Office Examiner during the prosecution of the Whang '023 patent was cognizant of the requirements concerning adequate disclosure because certain claims to subject matter not at issue in this action were rejected on the basis of inadequate disclosure. Those rejected claims were canceled from the patent application before the Whang '023 patent issued from the Patent Office on August 11, 1970 (DX A; R. 2307, 2368).

79. The specification of the Whang '023 patent contains a description of the invention in such full, clear, concise and exact terms as to enable the modem invention thereof to be made and used by those skilled in the art. Those skilled in the art can readily construct and operate

a modem on the basis of the disclosed subject matter of the Whang '023 patent (R. 2307, 2308). The asserted claims of the Whang '023 patent in suit particularly point out and distinctly claim the Whang modem invention, and one having ordinary skill in the modem art when considering the asserted claims in light of the Whang specification would know which modems are covered by the asserted claims (R. 2307, 2308).

80. The defendants did not convincingly dispute Whang's testimony (R. 828, 843-879, 891-896, 902-925) that the DS-4800 includes each and every element recited in claims 1-22, 25, 27-29, 31, 32, 36 and 37 of the Whang '023 patent in suit or the equivalent thereof. Each of the elements of the DS-4800 performs substantially the same function in substantially the same manner to obtain the same end results as do the corresponding elements of both the Whang '023 patent claims and the Milgo modem 4400/48 which is covered by the Whang '023 patent (R. 921-923). The accused DS-4800 data set includes each and every element of the claims at issue of the Whang '023 patent and such elements of the DS-4800 accomplish the same or substantially the same functions as described and claimed in the Whang '023 patent in suit (R. 921-923 and Whang testimony at above-noted pages of the Record).

81. Plaintiff's Exhibit 17 includes the claims at issue of the Whang '023 patent in suit and includes drawings selected from and accurately representative of the operation of the DS-4800 data set with each and every claimed element marked with colors which match the corresponding components as depicted in the drawings from the DS-4800 data set manual as presented in PX 17. Those claims. element-by-element and function-by-function, were applied by Whang to show that each and every claimed

element and function is present in the DS-4800 data set. Dr. Beam, although not prepared to admit literal word-by-word infringement by the DS-4800 of the Whang '023 patent claims at issue, admitted the Whang '023 claims "are extremely broad . . . and that they could be read on most any modem." (R. 1994). Dr. Beam only questioned from an infringement standpoint whether the DS-4800 filters satisfied the filter means of the Whang '023 patent claims (R. 1994); but he admitted that he had no technical reason to doubt that the Milgo 4400/48 was covered by the Whang patent because he never tested a Milgo 4400/48 (R. 1997). In fact, Beam never tested a DS-4800 (R. 1997) and accepted the plaintiff's representation that the filter characteristics of the DS-4800 were accurate and correctly shown in PX 17, page 24 (R. 1995, 1996). Whang's testimony that the skirts of the DS-4800 composite filter are virtually identical and are right on top of the Milgo 4400/48 curve traced by test equipment in Court (PX 148) was not disputed (R. 879). Beam admitted that the amplitude characteristic of the composite filter for the Milgo 4400/48 when expressed in roll-off is a very close approximation to a .5 or 50% roll-off curve (R. 1481).

82. The accused DS-4800 data set includes each and every element recited in claims 1-19 and 21 of the Ragsdale '381 patent in suit or an equivalent thereof. Each of the elements of the DS-4800 data set perform substantially the same function in substantially the same manner to obtain the same end results as do the corresponding elements of both the claims in suit of the Payne '023 and Ragsdale '381 patents (PX 20 and PX 19 respectively) as well as the corresponding elements of the patented Milgo 4400/48 modem which is covered by the Payne '023 and Ragsdale '381 patents.

83. Plaintiff's Exhibit 19 includes the claims at issue in the Ragsdale '381 patent colored with colors which are matched to corresponding elements of the DS-4800 as depicted in drawings from the DS-4800 manual, which drawings accurately depict and correctly represent the operation of the DS-4800. The claims of Ragsdale '381, element-by-element and function-by-function, were applied by Ragsdale and disclosed that each and every claimed element and function is present in the DS-4800 (R. 1167-1222).

84. Plaintiff's Exhibit 20 includes the claims at issue in the Payne '023 patent colored with colors which are matched to corresponding elements of the DS-4800 as depicted in drawings from the DS-4800 manual, which drawings accurately depict and correctly represent the operation of the DS-4800. The claims of the Payne '023 patent, element-by-element and function-by-function, were applied by Ragsdale and proved that each and every claimed element and function is present in the DS-4800 (R. 1134-1165).

85. The defendants sought to distinguish the operation of the DS-4800 from the claims of the Payne '023 and Ragsdale '381 patents on the basis that the DS-4800 did not have the counting means called for in the claims because the counting means in the DS-4800 includes two interrelated counters designated by Dr. Beam as a divide-by-256 counter and a phase difference, or reference, counter (R. 1898-1902). The phase reference counter doubles as a first storage register when stopped each modulation period, and Dr. Beam admitted that such a counter when stopped is a storage register that stored signals representative of 180°, 90° and 45°, i.e., multiples of 45° as claimed in the Payne '023 and Ragsdale '381 patents. It is admitted that the DS-4800 employs a digital detector which includes

center sampling for phase angle determination (PX 5, Admission 68, 70). The phase reference counter is connected to and is controlled by the divide-by-256 counter. It was not disputed by Dr. Beam that the entire circuit of the DS-4800 digital detector cooperates to produce an output signal which is a measure of the phase difference in the data containing I.F. input signal and that it has an oscillator, a high speed binary counter, phase comparison circuits, registers, and adder and a phase difference to data decoder circuit (R. 1898-1905).

86. Ragsdale testified that the only difference in operation between the DS-4800 and the Payne '023 and Ragsdale '381 patents was that the patents disclose a parallel transfer of signals from a counter to a register, whereas in the DS-4800 there is a serial transfer of signals from the divide-by-256 counter to the phase difference or reference, counter/register. The claims at issue do not define either a parallel or serial transfer and the defendants' argument on this point is not correct because in both cases (parallel and serial transfer) there is a measurement of the phase relationship from a counting means with a selected I.F. transition of the input I.F. signal. Both serial and parallel transfer accomplish the same end result and are electrically and functionally equivalent to each other; and, in any event, are not called out by the claims at issue (R. 1135, 1161, 1162; R. 2413-2433).

87. An early Rixon drawing (PX 27 and PX 28) disclosed a parallel data transfer of signals from a counting means to a first register of a pair of registers. Although some doubt exists as to some of the dates on the plaintiff's Exhibits 27 and 28, it bears a 1969 date by A. Dargis (R. 1214-1216). The difference between serial and parallel data transfer does not alter the function of the DS-4800 in that the DS-4800 with serial data transfer performs

substantially the same function in substantially the same manner to obtain the same end results as do the corresponding elements of the claims in issue of the Payne '023 and Ragsdale '381 patents and as do the corresponding elements of the 4400/48 which incorporates the claimed inventions of the Payne '023 and Ragsdale '381 patents in suit (R. 1220-1222).

88. Defendants failed to prove that anything in the file wrappers of any of the patents in suit prevented the plaintiff from reading the claims in issue on the DS-4800 data set.

89. The accused DS-2400 data set literally includes each and every element of claim 5 of the Payne '023 patent; and each of the elements of the DS-2400 data set perform substantially the same function, in substantially the same manner, to obtain the same end results as do the claims at issue of the Payne '023 patent. Plaintiff does not contest the defendants' position that the DS-2400 does not include a storage register and comparing means which is physically separated from the counting means, but rather rely on the doctrine of equivalents for infringement of all claims of the Payne '023 patent except for claim 6, which claim plaintiff contends liberally covers, element-by-element and function-by-function, the DS-2400 data set (R. 1244, 1245; R. 1235-1263).

90. Plaintiff's Exhibit 22 includes the claims at issue in the Payne '023 patent colored with colors which are matched to corresponding elements of the DS-2400 as depicted in drawings and function charts from the DS-2400 manual, which drawings and function charts accurately depict and correctly represent the operation of the DS-2400 (R. 1235, 1249, 1250). The claims of the Payne '023 patent, element-by-element and function-by-function, were applied by Ragsdale and proved that each and every

claimed element and function is present in the DS-2400 (R. 1235-1263).

91. Dr. Beam denied that the DS-2400 was covered by the Payne '023 patent claims because the counting means of the DS-2400 is stopped briefly once each modulation period and thus was not a "counting means for producing an output signal which varies with time at a fixed repetition rate" as set out, for example, in claim 1 of the Payne '023 patent (R. 1865). Ragsdale calculated that the counting means of the DS-2400 runs for 99.77% of the time during each modulation period; and when it is restarted, the counting means is pre-set as though it had never stopped running (R. 2433-2435). The counting means of the claims of Payne '023 is the functional equivalent of the counting means of the DS-2400 (R. 2436).

92. Beam also denied coverage of the DS-2400 on the basis that the counter was not physically separate from the first and second storage registers and that the DS-2400 thus operated in a different manner than the claims of the Payne '023 patent (R. 1863-1880). Ragsdale showed that the counter of the DS-2400 when stopped acted as a register and that the reset and timing operation for the counter of the DS-2400 performed substantially the same function, in substantially the same manner, to obtain the same end results as the claims of Payne '023 (R. 1235-1263; R. 1263; R. 2436). Beam on cross-examination agreed with the plaintiff that a counter can act as a storage register, and that the phase difference counter of the DS-2400 can act and serve as a register and adder. Beam also admitted that the DS-2400 was a complicated operation (R. 2044).

93. The defendants failed to prove that anything in the file wrapper of the Payne '023 patent prevented the

plaintiff from reading the claims in issue on the DS-2400 data set.

94. UBC has sold and serviced modems which infringed Milgo patent 3,524,023 and has actively induced infringement of the Milgo patents by and through its wholly-owned subsidiary Rixon II.

From the foregoing Findings of Fact on the general issues of validity and infringement of plaintiff's patents, the Court reaches the following:

CONCLUSIONS OF LAW

1. This Court has jurisdiction over the parties and over the subject matter of this suit. Venue is proper in this District.

2. Plaintiff has title to United States Letters Patent Nos. 3,524,023 (Whang); 3,590,381 (Ragsdale); and 3,643,023 (Payne, et al.), and is the owner of all rights thereunder including the rights to sue for and to recover for past infringement.

3. United States Letters Patent No. 3,524,023, entitled BAND LIMITED TELEPHONE LINE DATA COMMUNICATION SYSTEM, as to Claims 19-22, 25, 27-29, 31, 32 and 36-37, is in all respects valid and subsisting in law.

4. United States Letters Patent No. 3,590,381, entitled DIGITAL DIFFERENTIAL ANGLE DEMODULATOR, as to Claims 1-12, 17-19 and 21, is in all respects valid and subsisting in law.

5. United States Letters Patent No. 3,643,023, entitled DIFFERENTIAL PHASE MODULATOR AND DEMODULATOR UTILIZING RELATIVE PHASE DIFFERENCES AT THE CENTER OF THE MODULATION PERIODS, as

to Claims 1-5, 7, and 10-20, is in all respects valid and subsisting in law.

6. The invention defined in Claims 19-22, 25, 27-29, 31, 32 and 36-37 of U.S. Letters Patent No. 3,524,023 would not have been obvious to one of ordinary skill in the art at the time the invention thereof was made.

7. The invention defined in Claims 1-12, 17-19 and 21 of U.S. Letters Patent No. 3,590,381 would not have been obvious to one of ordinary skill in the art at the time the invention thereof was made.

8. The invention defined in Claims 1-5, 7, 9-20 of U.S. Letters Patent No. 3,643,023 would not have been obvious to one of ordinary skill in the art at the time the invention thereof was made.

9. Evidence of copying is properly admissible on the issue of obviousness. *Mott Corporation v. Sunflower Industries, Inc.*, 314 F.2d 872 (10th Cir.).

10. Evidence of copying is properly admissible on the issue of infringement. *Lever Bros. Co. v. Procter & Gamble Mfg. Co.*, 139 F.2d 633 (4th Cir.).

11. Each of the inventions of U.S. Letters Patent Nos. 3,524,023; 3,590,381; and 3,643,023, as to Claims 19-22, 25, 27-29, 31, 32 and 36-37; 1-12, 17-19 and 21; 1-5, 7 and 10-20, respectively, are novel and useful and meet the requirements of 35 U.S.C. §§ 101 and 102.

12. The unobvious requirement of 35 U.S.C. §103 is fulfilled by an inventor who makes a new and useful improvement where those skilled in the art have failed after repeated efforts to do so. *McCullough Tool Co. v. Well Surveys, Inc.*, 343 F.2d 381, 399.

13. United States Letters Patent Nos. 3,534,023, 3,590,381; and 3,643,023, as to Claims 19-22, 25, 27-29, 31, 32 and 36-37; 1-12, 17-19 and 21; 1-5, 7, and 10-20, respectively, are infringed by Rixon II by its manufacture and sale of the accused data sets, and by UBC by the sale of the accused data sets infringing Whang patent 3,524,023 until January 1, 1972. Thereafter UBC actively induced the infringement of the Milgo patents by and through Rixon II.

14. Each Conclusion of Law set forth in the foregoing Conclusions of Law deemed to be a Finding of Fact is hereby found to be a Finding of Fact.

APPENDIX "A"

Plaintiff, on September 3, 1975, and before commencement of trial, submitted a trial brief (Doc. 134) to which was attached a "Glossary of Terms" (Exhibit A with brief). These definitions were reviewed with counsel for the parties and with exception of changes hereafter noted, were considered and used by the Court in its effort to understand the many technical terms, in some instances, illustrated by drawings and diagrams.

Under the item "Bit Error Rate," pp. 3 and 4, there is stricken the words, "generally, a modem is expected to perfom better than a 10×10^{-6} error rate."

Under the item "Synchronization," on p. 11, the second sentence is stricken.

Under the item "Phase Lock Loop," on pp. 11-12, the last sentence is stricken.

Under the item "Envelope of a Carrier," on p. 39, the third sentence is stricken and the following language is substituted:

"But this complex phase modulated carrier signal may be limited by a composite filter."

Under the item "Coherent Phase Detection," pp. 43-44, the words "in the patented Milgo modems" are stricken from line 7 at top of page 44.

Under the item "Percent Roll-Off," pp. 45-46, the language in lines 4 to 7, inclusive, top of page 46, is stricken.

Item entitled "Optimum Roll-Off," p. 46, is stricken.

FINDINGS OF FACT
ON
ISSUE OF UNITED'S USE OF RIXON II AND UBC AS MERE INSTRUMENTALITIES

STATEMENT

The Court has determined that the patents of the plaintiff were valid and that they were infringed by Rixon. Rixon is not a party to this action and plaintiff seeks to impose responsibility for the acts of Rixon and UBC on United and UBC on the grounds and for the reason, as plaintiff contends, that Rixon and defendant UBC were mere instrumentalities of United, and, therefore, United is legally liable for what its subsidiaries did.

Defendants have, among the other defenses raised by them, denied that under existing rules of law applicable here, they are not chargeable with the wrongful acts of Rixon.

This Court has had previous occasion to consider the matter of whether a parent company, owning the stock of a subsidiary, was using its subsidiaries merely as an instrumentality to conduct its own personal business in perpetrating fraud or injustice on third parties having dealings with the subsidiaries. The Court is obliged to

declare that a holding or parent company has a separate corporate existence and is to be treated separately from the subsidiary in absence of circumstances justifying disregard of corporate entity. Other guidelines are set forth in the excellent opinion of Judge Hill in the case of *Quarles v. Fuqua Industries, Inc.*, 504 F.2d 1358. To further elaborate on the legal issue involved would serve no useful purpose. The Court believes that plaintiff has failed to prove that United exercised such control over its subsidiaries in this case that they were merely instrumentalities to conduct United's business. The domination by United over its subsidiaries has not been shown to exist by a preponderance of the evidence.

After considering all the evidence, the well-prepared briefs, the arguments of counsel and the Requests for Findings and Conclusions on this issue, the Court makes the following:

FINDINGS OF FACT

1. The names of several individuals appear in the record and they are identified, as follows:

From July 7, 1969, until January 13, 1970, James L. Hollis was Chairman of the Board and Chief Executive Officer of Rixon II. From July 7, 1969, to October 5, 1972, M. W. Horrell was President of Rixon II and from January 13, 1970, to October 5, 1972, he was Chief Executive Officer as well as President of Rixon II (DX E-2).

From January 8, 1970, and thereafter at all times relevant to this suit Robert B. Liepold was President and Chief Executive Officer of UBC and was not an officer, director or employee of United (DX F-2) but he said he did report to Mr. Deaver as his boss.

Reed Manning was Vice-President of Technology of Rixon II.

Danny Deaver was Vice-President of United and its Chief Executive Officer. He and Liepold voted shares of Rixon on behalf of United to elect the Board of Directors and the Directors appointed officers of Rixon.

2. In October, 1968, United entered into an agreement in principle to purchase Rixon I (PX 39/69). At that time, Mr. James L. Hollis was Chairman of the Board, Chief Executive Officer, substantial stockholder of, and the person that ran Rixon I subject to restrictions or limitations of the Board of Directors of Rixon I (R. 2230). Shortly after the agreement in principle and prior to the actual transfer of assets, Mr. Hollis told United's President that ". . . administrative direction from Danny Deaver (United's Vice-President) will be no problem . . . ." (PX 40/117, parentheses added).

3. Most of United's subsidiaries are telephone companies. United has telephone subsidiaries in 22 or 23 states serving 3.1 or 3.2 million telephones through its telephone subsidiaries (R. 1608). United's telephone subsidiaries are collectively known as the United Telephone System (PX 39/65).

4. In 1966 and subsequent years United acquired stock in various non-telephone and non-utility industries. Its first such acquisition was 49 percent of the stock of North Electric Company which is in the business of manufacturing telephone switching and peripheral and auxiliary gear to the switching equipment (R. 1612-1613). United has also acquired other non-telephone companies where it believed a profit potential existed (R. 1613-1614). In almost every instance, United has become the sole stockholder of its subsidiaries, both telephone and non-telephone (R. 1614-1616).

5. United System Service, Inc., is a non-profit wholly-owned subsidiary of United which is staffed with legal, advertising, public relations, telephone engineering, inside and outside plant personnel that provides the corporate accounting and corporate legal work for United and serves as a source of expertise in various areas for the operating subsidiaries of United (R. 1608-1609). Each subsidiary of United is charged for and pays its proportionate share for services rendered to it by United System Service (Deaver Dep. 117-118).

6. Until the beginning of 1972, United had officers and directors but no employees (R. 1609; Baker Dep. 18).

7. On October 23, 1968, an agreement in principle was entered into between Rixon Electronics, Inc., a Maryland corporation ("Rixon I"), and United contemplating the acquisition by a subsidiary to be formed by United of the business and assets of Rixon I in exchange for United stock (PX 43/200; R. 1717-1718). Earlier in October of 1968 D. H. Deaver, who was then Vice-President-Manufacturing of United, was involved in making an acquisition study of the business of Rixon I (R. 1621; PX 39/67; Deaver Dep. 6).

8. As of December 12, 1968, an Agreement and Plan of Reorganization was entered into between United and Rixon I whereby United agreed to issue to Rixon I shares of United's common stock in exchange for the conveyance by Rixon I of all of Rixon I's business and assets, less certain cash and marketable securities retained by Rixon I (DX G-2). The Agreement provided for a number of contingencies which were conditions precedent to the sale and transfer of Rixon I's assets and business pursuant to the Agreement (DX G-2). These including, among others, favorable action at a stockholders' meeting of Rixon I and the absence of any material adverse change in the

financial condition of Rixon I (DX G-2). The stock of Rixon I was listed on the American Stock Exchange (Horrell Dep. 37).

9. On July 3, 1969, the formal transfer of the assets of Rixon I to Rixon II took place. In July, 1969, the bylaws of Rixon II provided that the Chairman of the Board would be the Chief Executive Officer (DX E-2). At this time, Mr. Hollis was the Chairman of the Board of Rixon II and according to Mr. Deaver, the Chief Executive Officer of a United subsidiary had the responsibility for running the company (R. 1653-1654).

10. On July 14, 1969, Mr. Deaver in a letter to Rixon's President Mr. Horrell set out the guidelines as to how Rixon was to be managed (R. 1783-1785). In this letter, Mr. Deaver stated that Mr. Horrell would have "direct responsibility for managing and directing the day-to-day activities of Rixon Electronics. . . ." (PX 96). Mr. Deaver acknowledged a difference between the responsibility for day-to-day activities and the responsibility for running the company by setting the basic management policies. In the letter to Horrell, Mr. Deaver set out twelve key management policy matters which had to be discussed with him before they could be implemented by anyone at Rixon. Such matters included capital expenditure budgets, research and development budgets, financing requirements and arrangements, major pricing policies and changes, selection and appointment of officers and principal department heads and other department changes, salary increases where the resultant would exceed $20,000 per year, and any changes in overall compensation policies of the company, union contract negotiations, patent licenses, etc. (PX 96).

11. On May 23, 1969, United caused to be organized a Maryland corporation named New Rilexo, Inc. ("Rixon

II"), as a wholly-owned subsidiary (DX E-2 and G-2). On July 3, 1969, United issued to Rixon I 597,105 shares of its common stock, and Rixon I transferred and conveyed to Rixon II all of its business and assets (including, without limitation, its patents and permits), except certain cash and marketable securities retained by Rixon I (DX G-2). Rixon II assumed all of the liabilities and obligations of Rixon I then existing, except Rixon I's expenses relating to the transaction and certain outstanding stock options of Rixon I under its Employees' Stock Option Plans, which options were assumed by United (DX G-2). Rixon I changed its name to Rixon Liquidating Corporation after July 3, 1969, and remains in existence today in an active state (R. 2175).

12. United never at any time owned any stock of Rixon I and neither United nor any of its subsidiaries were represented on the Board of Directors of Rixon I (R. 1628). No directions or instructions of any kind were given by United or any of its subsidiaries to Rixon I (R. 1628). No evidence was introduced in the case showing any ownership, participation in management, or control by United or any of its subsidiaries of Rixon I.

13. Just prior to the transfer of assets to Rixon II, Mr. Deaver informed Mr. Hollis that any disputes between them concerning the operation of Rixon II would be resolved by the Board of Directors of Rixon II as long as resolution of the Board was not in conflict with basic United policy (PX 40/110). Deaver and later Liepold voted the shares of Rixon on behalf of United to elect Board of Directors (DX E-2, R. 1809-1810), and the Directors appointed the Rixon officers.

14. In January, 1970, United formed and completely financed a wholly-owned subsidiary, UBC (R. 1645). Rixon stock ownership was turned over to UBC (DX F-2),

as was the commercial sales activities for all Rixon products with the exception of Government sales.

15. The organization of Rixon II by United and the acquisition by Rixon II of Rixon I's assets and business were for legitimate business reasons (PX 39/67). There was no evidence introduced to show that Rixon II was organized or Rixon I's assets and business acquired for any illegal, improper, or fraudulent purpose, with respect to Milgo or any other person or corporation.

16. From the time that Mr. Hollis died in April of 1970 until Rixon II's assets were sold to Sangamo Electric Company in September of 1972, the Rixon Board and the UBC Board were comprised of virtually the same members (PX 180, PX 38/64B).

17. Mr. Deaver was Chairman of the Board of UBC from April 13, 1970 through September of 1972, and Mr. Liepold was President of UBC and Chairman of the Board of Rixon II from August, 1970 through September, 1972 (DX E-2, DX F-2).

18. Rixon II was required to furnish detailed monthly financial operating reports to Deaver and Liepold and others (PX 39, pp. 65, 114, R. 1757-1758).

19. United either provided the operating capital for UBC and Rixon by direct loans, or by guaranteeing loans from independent banks (PX 43/219D, R. 2208, PX 40/116). Rixon's Treasurer, Mr. Relyea, admitted that early in 1970, Rixon II could not have repaid the loans from United (R. 2239).

20. In September of 1970, Rixon management requested permission from Mr. Liepold to obtain authorization from Milgo to manufacture the infringing modems (PX 29/5 and 29/6). Liepold denied the request.

21. From the time of its organization on May 23, 1969, until June 24, 1970, when the stock of Rixon II was transferred by United to UBC, the stock of Rixon II was wholly owned by United (DX E-2 and F-2). UBC was organized as a Kansas corporation on January 5, 1970 (DX F-2). It was organized to enter the business of selling, engineering, installing and servicing private voice and data communications equipment, services and systems for sale or lease to business users (R. 1632). After the *Carterfone* decision wherein the FCC decided in 1968 that telephone subscribers could own or lease equipment that interconnects with the nationwide telephone system, United believed that there would be new business opportunities in supplying customers who desired to own their own end equipment and studied the creation and addition of a voice and data business communications system (R. 1629-1631). The outgrowth of this study was the formation of UBC (R. 1631). The original concept of the scope of UBC's activities and business was to provide a business customer his own owned voice and/or data communications system (R. 1632). It was not intended that UBC be limited to the marketing of products of United affiliated companies (R. 1632). The original concept behind UBC was never achieved, but UBC did enter into the marketing of products of non-United affiliated companies as well as United affiliated companies, including products of Rixon II (R. 1632-1633).

22. The business of Rixon I had been primarily but not exclusively government contract business, and its sales program relied principally upon manufacturer's representatives (PX 39/67). There were discussions between Rixon and United of Rixon expanding into the commercial field, and both United and the management of Rixon II were in favor of this development (R. 1633-1634 and 2179-2180).

23. On June 24, 1970, United transferred to UBC all of the outstanding stock of Rixon II, and Rixon II was at all times thereafter a wholly-owned subsidiary of UBC (DX E-2).

24. Beginning in July, 1970, UBC undertook the marketing of certain products of Rixon II, including modems later charged by plaintiff as infringing plaintiff's patents. At the time UBC undertook the marketing of Rixon II products neither the Whang '023 patent nor the other patents involved in this suit had been issued.

25. The organization of UBC, the transfer of the stock of Rixon II to UBC, and the transfer of commercial marketing responsibilities to UBC for products of Rixon II and other United affiliated and non-United affiliated companies were for legitimate business purposes (PX 39/70; R. 1629-1633). There was no evidence introduced to show that UBC was organized or functioned as a sham or for any illegal, improper, or fraudulent purpose, with respect to Milgo or any other company or person.

26. The Rixon marketing function was transferred back from UBC to Rixon II on January 1, 1972 (R. 2198; PX 41/121). At that time certain Rixon II products in UBC's inventory were considered obsolete and were written off by UBC at the request of a joint committee meeting between employees of Rixon II and UBC. The largest part of the inventory of currently marketable finished products was retained physically by UBC in its warehouse for Rixon II under an arrangement whereby payment of the transfer price by Rixon II to UBC was deferred until the products were sold by Rixon II to its customers. As Rixon sold these products and they were shipped to Rixon customers in 1972, Rixon II reimbursed UBC at the transfer price that Rixon had originally charged

UBC when the products were sold by Rixon II to UBC, plus interest from January 1, 1972 (R. 2198; PX 72).

27. The UBC warehouse was contiguous to the Rixon buildings and was manned by Rixon employees, but the costs of building rent, telephone, salary for the Rixon employees, etc., were accumulated by Rixon II and charged to and reimbursed by UBC on a monthly basis (R. 2199; Horrell Dep. 38). UBC paid rent for the warehouse space to Rixon II (R. 2199; Liepold Dep. 41).

28. By way of a letter of intent (PX 40/115) dated August 18, 1972, United and Sangamo Electric Company proposed (among other things) to form "a joint venture corporation to be owned by United Telecommunications, Inc. or United Business Communications, Inc. (hereinafter called United) and Sangamo Electric Company (Sangamo), for the purpose of engaging in the design, manufacture and sale of telecommunication equipment and related products." The joint venture company became Rixon III. United and Sangamo also proposed that the ". . . net assets to be contributed by United shall be essentially those assets owned or used by Rixon Electronics, Inc. (Rixon II), a wholly-owned subsidiary of United (including certain inventory of Rixon manufactured products held by United Business Communications, Inc. to be transferred to Rixon) . . . ." United also proposed with reference to this lawsuit to hold Rixon III "harmless against damages arising out of all such claims (by Milgo) to date and extending to all deliveries of said equipment (DS-4800) during the three years after the effective date of the joint venture." (Material in parenthesis added, page 5 of PX 40/115). On October 1, 1972, by an Indenture of General Conveyance and Assumption of Liabilities between Rixon II and Rixon III, Rixon II conveyed substantially all of its assets and business to Rixon III organized by Sangamo

(DX H-2). The transfer price of the Rixon assets was the book value thereof (R. 2206).

29. There is no evidence that on or after January 1, 1972, UBC sold any of the allegedly infringing modems. All sales of Rixon II modems on or after January 1, 1972, were by Rixon II (R. 2198; PX 72).

30. United through its Executive Committee and Board of Directors was responsible for establishing overall policy goals and objectives for the entire United operation. Through its Executive Committee it provided guidance and assistance to individual subsidiaries but, generally, initiative was left to the subsidiaries. Each subsidiary was required to accept mutually agreed upon objectives and responsibilities but was not subject to day-to-day United supervision of its operations. Rixon II and the other subsidiaries were free to accept or reject United's staff services as deemed appropriate by Rixon management and transactions between United subsidiaries were at arms length (R. 1616, 1618, 1635, 1636, 2192; PX 40/110).

31. Rixon II was responsible for defining its objective and the methods it intended to accomplish what it projected. It was required to spell out the reservations it might have over which it had no control and it had to define how it would be affected if those objectives were not accomplished (R. 2189-2190).

32. Mr. Deaver approved most of the loans to Rixon II on behalf of United, and the moneys borrowed by Rixon II were carried by Rixon II as an obligation and were hoped to be repaid (R. 1799, 2200). As early as 1970, Rixon II's financial condition had deteriorated to the point where it could not have repaid the loans (R. 2239). Interest on the borrowed money was paid monthly by Rixon II (R. 2200).

33. Each subsidiary of United was managed as a profit responsible unit which was required to accept mutually agreed upon objectives and responsibilities but was not subject to day-to-day United supervision of its operations and was expected to stand on its own two feet; it had to provide its own personnel, the number and cost of which should be compatible with profit center objectives (PX 40/110; R. 2189-2190; Deaver Dep. 47).

34. The individual subsidiaries of United pay their own officers and employees (R. 1621).

35. The individual subsidiaries prepare their own budgets, which are reviewed by their respective Boards of Directors (R. 1621).

36. No day-to-day guidance was furnished by Mr. Deaver or anyone else from United to Rixon II (R. 1635-1636).

37. The Rixon II Board meetings were free flowing discussions on any of the problems, a source of exchange of ideas and a determination of finally what would be done (R. 1635). There was no domination of any directors' meetings of Rixon II by any one or two individuals (R. 2187). Rixon II was responsible for defining its objectives and the methods it intended to use to accomplish what it projected (R. 2190).

38. Other than general guidelines set down by United there was no interference in day-to-day operations of Rixon II.

39. Neither United nor UBC ever directly or indirectly paid the operating expenses of Rixon II (R. 2206). However, Rixon II had to borrow money from United to pay such operating expenses (R. 2239).

40. Rixon II hired and fired its own employees (R. 2207).

41. Rixon II kept separate books and records, prepared its own budgets, which were subject to review by its Board of Directors, had separate offices from UBC and/or United, had a separate payroll from which it paid all of its own officers and employees (R. 2201-2202; Horrell Dep. 37).

42. The President of Rixon II controlled the engineering department and the research and development department of Rixon II (R. 1649). The quality control facilities at Rixon II were controlled by the manufacturing operation which reported separately to Mr. Horrell (R. 1649-1650).

Neither Mr. Deaver nor anyone at United dictated or instructed Rixon II concerning the arrangement of plant facilities of Rixon II (R. 1650).

43. Mr. Relyea, Treasurer of Rixon II, was primarily in charge of pricing Rixon products until UBC took over the Rixon marketing functions in June of 1970 (R. 2181). During the time that UBC had the marketing function, until January 1, 1972, Rixon II continued to make manufacturing cost estimates and recommended the establishment of transfer prices between Rixon II and UBC (R. 2181). Rixon II sold its products to UBC for a price which returned Rixon II's full manufacturing costs, its indirect costs, and a margin profit on its investment (R. 2181).

44. Mr. Relyea, although not a director, attended the meetings of the Board of Directors of Rixon II and kept the minutes of such meetings (R. 2184-2185). There was no domination of the directors' meetings and Rixon II by any one or two individuals.

Mr. Relyea, Treasurer of Rixon II, was never given instructions by Mr. Deaver as to what he should do. Mr. Relyea's instructions came from either Mr. Hollis or Mr. Horrell (R. 2192).

Generally, Rixon II was responsible for developing its own operating, planning and procedures and at regular intervals reported these plans through the President and Board of Directors of Rixon II (Relyea Dep. 95).

UBC did not make loans to Rixon II (Liepold Dep. 48).

45. During the years involved in this lawsuit United filed a corporate consolidated federal income tax return. Each subsidiary figured its own tax on a stand-alone basis and paid to United the funds for such taxes. The returns were consolidated and the final return paid for by United. Any subsidiary which had a loss, and, thus would be entitled to a refund under the tax laws, would be given a refund by United in the same way that they would have received their refund if they were reporting directly to IRS (R. 1619; Liepold Dep. 53). If any subsidiary had a loss carry-forward, United would give the subsidiary credit for the amount the subsidiary would have received under the loss carry-forward provision (R. 1619-1620).

46. During the time that UBC was marketing products of Rixon II the price charged by Rixon II to UBC was a negotiated price, fair to both companies. Mr. Deaver was not consulted with respect to the pricing (Liepold Dep. 60, 61). The transfer price was designed to yield to Rixon the full return on their cost and operating expenses and ". . . some nominal profit in the area of five percent . . . ."

The day-to-day operations of UBC were in the hands of Mr. Liepold and the UBC organization. Although Mr. Deaver was on the Board of Directors of UBC, neither he nor anyone at United gave any directions or instructions to UBC employees (R. 1646).

47. UBC and Rixon kept separate and independent books and records, did their own hiring and firing, had separate payrolls from each other and from United, handled the purchasing of their own supplies, made their own budgets, and submitted these budgets to their respective Boards of Directors, and kept separate corporate minutes, and kept separate corporate minute books (R. 1647; DX E-2; DX F-2).

48. Neither Rixon II, UBC, nor United used property commonly (R. 1650).

49. United advances funds to its subsidiaries, including Rixon II and UBC, which request financing on a temporary basis (R. 1617; Baker Dep. 43). The ability of the subsidiary to repay the loan is only one of the factors considered by United in loaning money to its subsidiaries (Deaver Dep., pp. 136-137). All subsidiaries of United are free to go to any other lending agency to borrow funds (R. 1618). All of United's subsidiaries have their own bank lines and borrow from banks if their credit is acceptable (R. 1618, 2201). United charges interest on the money it advances its subsidiaries at the prime rate plus one-half percent (R. 1618). United's lending to its subsidiaries is usually unprofitable for United (R. 1618).

50. The day-to-day operations of UBC were in the hands of Mr. Liepold and the UBC organization. Mr. Deaver was on the Board of Directors of UBC but, to Mr. Deaver's knowledge, neither he nor anyone at United gave any directions or instructions to UBC employees (R. 1646).

51. Mr. Deaver was designated by United to follow the non-telephone subsidiaries and report to the Board of Directors of United regarding them (R. 1708). Mr. Deaver requested that (1) earnings and cash forecasts, (2) capital expenditure budgets, (3) research budgets and major research projects, (4) new fields of endeavor, (5) abandonment of existing fields of endeavor, (6) new financing requirements and arrangements, (7) major pricing policies and changes, (8) major organization changes, (9) salary increases over a certain amount, (10) union contract negotiations, etc. ". . . be discussed with me before finalization or implementation" (PX 96, at 2).

52. Mr. Horrell, President of Rixon II, was advised by memorandum from Reed Manning, Vice-President of Technology of Rixon II, dated September 3, 1970, of the issuance of the Whang '023 patent and of "our first engineering opinion . . . that we could not get around all of the patent claims and still design a modem that would be anything like the PM48 concept." Mr. Manning also suggested setting up a reserve fund to cover potential royalty payments (PX 29/6). Mr. Horrell discussed the matter with Mr. Liepold, and they discussed the matter at a meeting with Rixon II engineers. Mr. Manning, one of the engineers in attendance at the meeting, was of the opinion ". . . that this was a possible infringement." Mr. Liepold could not recall any of the other engineers at the meeting but stated that it was his recollection the collective opinion was that there was no clear-cut indication that the patents were being infringed. Neither Mr. Horrell nor Mr. Liepold reviewed the Milgo patent in detail. Mr. Liepold could not even recall one of the reasons on which the opinion of non-infringement was based. Mr. Liepold did not request any opinion from outside counsel or even "anyone on the legal staff of United or the Service

Company" as to whether or not the Vice-President Reed Manning was correct in his opinion that the Milgo patent was possibly infringed. Liepold did not discuss the question of patent infringement with anyone else at UBC or United (Liepold Dep. pp. 18-24; Horrell Dep. pp. 30-31).

53. There is no evidence in the record showing any written complaint by Milgo to United, UBC or Rixon II of any alleged infringement of the Whang '023 patent until the filing of plaintiff's complaint in the instant suit. However, Milgo informed Rixon II's modem scientists that it had patents pending covering the subject matter of the patents in suit as early as July, 1969 (PX 29/4). At least Rixon II's and UBC's management had notice that Rixon II's Vice-President Manning considered that the Whang '023 patent was possibly infringed by the defendants' modems as early as September, 1970 (PX 29/6).

54. There is no evidence in the record showing any notice by Milgo to United, UBC or Rixon II of any alleged infringement of the Ragsdale '023 or the Ragsdale '381 patent until the filing of Milgo's motion to file its amended complaint on August 11, 1972. However, the Ragsdale patent '381 was called to the defendants' attention on February 14, 1972, during the deposition of Mr. Al Dargis, a Rixon employee (PX 32). This patent makes reference to the application which issued as the Whang .023 patent.

55. Except for Mr. Horrell, who became a director of UBC, no officer or director of United or UBC ever served as an officer of Rixon II (Deaver Dep. 79).

56. Each Finding of Fact set forth in the foregoing Findings of Fact deemed to be a Conclusion of Law is hereby found to be a Conclusion.

From the foregoing Facts on the issue of use by United of Rixon and UBC as mere instrumentalities, the Court reaches the following:

CONCLUSIONS OF LAW

1. Rixon II was not the mere instrumentality, alter ego, or agent of United at any time after August 11, 1970.

2. Rixon II was the mere instrumentality, alter ego, or agent of UBC.

3. United has never made, leased, used or sold a Rixon data set, Model PM-48 or DS-48 or DS-2400.

4. On or after January 1, 1972, UBC did not make, lease, use or sell a Rixon data set, Model PM-48 or DS-4800 or DS-2400, but UBC did thereafter actively induce infringement of the claims of the Milgo patents through its subsidiary Rixon II.

5. At no time did United actively induce infringement of any of the claims of the alleged Milgo patents involved in this suit.

6. Each Conclusion of Law set forth in the foregoing Conclusions of Law deemed to be a Finding of Fact is hereby found to be a Finding of Fact.

The Court reserves ruling on the issue of willfulness until the matter of damages is considered.

Dated at Topeka, Kansas, this 13 day of January, 1976.

ORDER TO CORRECT TYPOGRAPHICAL ERRORS IN FINDING 89

(Filed January 27, 1976)

Plaintiff's counsel have filed a Motion to Amend Finding of Fact No. 89 by deleting in line 10 the number "6" and to substitute the number "5" to correspond with

the reference in line 2 of said finding, and in line 11 of the same finding to delete the word "liberally" and to substitute the word "literally" to correspond with the statement contained in the first line of said finding.

The Court has reviewed the finding and concludes that the motion of the plaintiff is well taken and that the requested corrections and amendments should be made.

IT IS THEREFORE BY THE COURT ORDERED AND ADJUDGED that the Finding of Fact No. 89 be corrected to read as follows:

> "89. The accused DS-2400 data set literally includes each and every element of claim 5 of the Payne '023 patent; and each of the elements of the DS-2400 data set perform substantially the same function, in substantially the same manner, to obtain the same end results as do the claims at issue of the Payne '023 patent. Plaintiff does not contest the defendants' position that the DS-2400 does not include a storage register and comparing means which is physically separated from the counting means, but rather rely on the doctrine of equivalents for infringement of all claims of the Payne '023 patent except for claim 5, which claim plaintiff contends literally covers, element-by-element and function-by-function, the DS-2400 data set (R. 1244, 1245; R. 1235-1263)."

Dated at Topeka, Kansas, this 27th day of January, 1976.

FINDINGS OF FACT AND CONCLUSIONS OF LAW ON ISSUES OF WILLFULNESS AND DAMAGES

(Filed April 7, 1978)

STATEMENT

This Court initially heard and decided the issues of validity of the patents involved and the infringement by defendants of such patents, reserving for further consideration the question of damages and the issue of willfulness on the part of defendants for actively inducing infringement and for direct infringement by the agency and the *alter ego* of United Business Communications (UBC), which operated under the corporate name of Rixon Electronics, Inc. (Rixon II). The defendant United Telecommunications, Inc., was found not to have infringed the patents of plaintiff in controversy.

After reviewing all the evidence in the case and after considering all reasonable inferences that may be drawn from the established facts, it is my conclusion that in considering the basis of awarding damages in this case, the "reasonable royalty" measure is inadequate. An infringement made so willfully and intentionally by defendant requires the application of a more stringent rule and one that more equitably treats the situation where, as here, the infringement was made with reckless disregard of the consequences.

In this case, though defendant undertakes to persuade the Court that there were many modems on the market that came in competition with those on which patents had been obtained by plaintiff, the fact remains that the significant and remarkable developments obtained in these patents were not duplicated by suppliers on the market other than by defendant. The fact that defendant copied

the modems of plaintiff and of no other supplier supports a conclusion that no other source existed from which could be obtained the kind of modems providing the remarkable uses to which those of plaintiff could be put.

Thus, the sales made by defendant directly or through its agency Rixon II, of the infringing modems, deprived plaintiff of such sales and under the circumstances, it may be assumed, practically to a certainty, that the customers who bought the infringing devices would have bought plaintiff's modems if they had not bought the infringement. *Oil Well Improvement Co. v. Acme Foundry & Machine Co.*, 31 F.2d 989, 901 (8th Cir.).

The so-called "but for" rule does not require the injured party to negate all possibilities that the purchasers would not have bought a different product or that proof must be convincing beyond a reasonable doubt. On the contrary, I find that in all reasonable probability plaintiff would have made the sale of its modems if defendant had not made them. Furthermore, where the wrong done is so absolute, as here, the consequences of an inability to demonstrate the resulting loss with scientific accuracy rests on the infringer, as on any other wrongdoer. *Livesay Window Co. v. Livesay Industries*, 251 F.2d 469 (5th Cir.).

In oral argument, defendant's counsel advanced the unique contention that defendant was a victim of entrapment because plaintiff failed to mark its modems with a patent notice. Defendant contends that it was entitled to assume no patent was claimed and that no infringement could be made, thus, in effect, inducing defendant to proceed to sell and lease its infringing modems with that belief. The contention is specious, first, because entrapment is defined as the inducement of one to commit a crime not contemplated by the accused, but for the mere

purpose of instituting a criminal prosecution against him. 21 Am.Jur.2d *Criminal Law*, §143, at 211. Next, for the defense of entrapment to apply, the accused must have been innocent of any intent to do wrong. Here, defendant cannot raise any cloak of innocent purpose since the facts establish a deliberate design to infringe. Again, the doctrine does not extend where the acts of inducement were performed by a private citizen, not an officer of the law. *Sorrels v. U.S.*, 278 U.S. 435, 451.

After reviewing all the record in the case, including the Findings of Fact and Conclusions of Law previously made and filed herein, all of which the Court now ratifies, confirms and approves, there remains the matter of determining the time period during which defendant directly or through its controlled and dominated subsidiary carried on sales and leases of infringing modems which resulted in the damage to plaintiff after it received notice of plaintiff's claim of infringement.

While there is evidence to establish the fact that defendant well knew that plaintiff had developed initially the Whang '023 patent and that an application for patent was pending, and knowing this, did deliberately and surreptitiously copy and utilize the device for its own benefit and gain, depriving plaintiff of the fruits thereof, the Court has concluded that since no notice of infringement was given to defendant until suit was filed on July 19, 1971, the period for determining damage for infringement by the PM-48, PM-48A and DS-4800 data sets should extend from July 19, 1971 through September 30, 1972.

The Ragsdale patent No. 3,590,381 was issued June 29, 1971. The Payne '023 patent No. 3,643,023 was issued February 15, 1972. Defendant's counsel concede that defendant had notice of claim of infringement on these

patents in connection with the defendant's DS-2400 data sets in July, 1972. As before, there is an abundance of evidence to support a finding that defendant knew before July 28, 1972 that its sale and deliveries of DS-2400 data sets were infringing plaintiff's patent. Nevertheless, notice of claim was necessary where modems of plaintiff bore no marking as required. The Court concludes that even though defendant, as a willful infringer, might be held to have waived notice of infringement, the date of July 28, 1972, seems appropriate under all the circumstances.

The Court is submitting with its Findings and Conclusions an Order setting forth its rulings and objections to certain depositions submitted by defendant.

The Court now, therefore, being fully advised in the premises, makes the following:

FINDINGS OF FACT

1. This is an accounting proceeding to determine the damages to be assessed against United Business Communications, Inc. (UBC), for the infringement by UBC and its subsidiary Rixon Electronics, Inc. (Rixon II), of the following patents of Milgo Electronic Corporation (Milgo): U. S. Patent No. 3,524,023 (the Whang '023 patent); U. S. Patent No. 3,590,381 (the Ragsdale '381 patent); and U. S. Patent No. 3,643,023 (the Payne '023 patent).

2. The Court has found and concluded that two data sets (or modems) manufactured by Rixon II and sold by either Rixon II or UBC, depending on the time period involved, infringe one or more of the patents in suit.

3. One data set is designed for transmitting digital data signals at a speed of 4800 bits per second (bps). In Rixon terminology, it was initially known as the PM 48 or PM 48A; subsequently it became identified as the

DS 4800 data set. The Whang '023 patent, Ragsdale '381 patent and the Payne '023 patent have been determined to cover the 4800 bps modem.

4. The other data set manufactured by Rixon and offered and sold by Rixon and UBC is a 2400 bps modem which the Court has concluded is covered by the Payne '023 patent. This modem is known generally by the designation DS 2400.

5. The Whang '023 patent issued August 11, 1970. The Complaint in this action was filed on July 19, 1971, and was served on defendant UBC on July 19, 1971. The Complaint as filed claimed infringement only of the Whang '023 patent. No statutory notice of a claim of infringement of the Whang '023 patent had been given by Milgo to Rixon II or UBC prior to the filing of the suit and service of the Complaint. It was not established that at the time the action was filed, Milgo or its sales subsidiary ICC had been marking any of the modems incorporating the subject matter of the patent and manufactured or sold by them, or the packaging therefor, with the number of the Whang '023 patent. The defendant had actual notice of the existence of the infringed Whang '023 patent at the time of its infringement and of the fact that the infringement was willful and deliberate as of August 11, 1970, the date the patent issued.

6. The Ragsdale '381 patent issued June 29, 1971. No statutory notice of a claim of infringement of this patent had been given by Milgo to Rixon II or UBC prior to July 28, 1972. It was not established that prior to that date Milgo or its sales subsidiary ICC had been marking any of its modems incorporating the subject matter of the patent, or the packaging therefor, with the number of the Ragsdale '381 patent.

7. The Payne '023 patent issued February 15, 1972. No statutory notice of a claim of infringement of this patent had been given to Rixon II of UBC with respect to the 4800 or 2400 bps modems of Rixon II or UBC prior to July 28, 1972. It was not established that prior to that date Milgo or its sales subsidiary ICC had been marking any of its modems incorporating the subject matter of the patent, or the packaging therefor, with the number of the Payne '023 patent.

8. In the spring of 1968, Rixon I sent some of its employees to evaluate and test the Milgo 4400/48 modem at a Kroger installation in Cincinnati. Rixon I recognized and the Milgo modem was a very good device and surprised the Rixon people because it performed so well. The Rixon Sebit modem was, according to Western Union tests, a "totally inadequate piece of equipment."

9. Rixon I actually acquired a Milgo modem Model 4400 48 that Rixon I secreted in a locked room for the purpose of dissecting it for copying purposes (PX 36/8). The serial numbers were scratched off Milgo's modem by Rixon (PX 117). Milgo was permitted to enter the Rixon II plant and obtained photographs of the copied Milgo modem Model 4400/48 and the room where it was originally kept.

10. Photographs of the Milgo modem have been submitted in evidence as plaintiff's exhibits PX 117, PX 118, PX 119 and PX 120. Mr. Schroeder, a Rixon employee who was in charge of the PM-48 program in 1968, identified those photographs as actual pictures of the Milgo model which had been used by Rixon in its copying and comparative testing of the Milgo inventions. Mr. Whang also recognized those photographs as being of a Milgo modem.

11. The room in which the Milgo modem was held for limited access to only a very few of Rixon's trusted employees (such as Messrs. Schroeder, Andrews, Dargis and Whartnaby) is depicted in PX 117, PX 36/57 and PX 36/58. Mr. Whartnaby testified at his deposition that he viewed Mr. Schroeder working in the room where the Milgo modem was kept (PX 37/7-9). The Milgo modem when seen by Mr. Whartnaby was on its side with one of the filter blocks pulled and wires hanging out (PX 37/7-9). One of the filter cans had been removed and a portion if its encapsulating material had been chipped away (DX 37/7-9). Mr. Schroeder testified that there was a great deal of difficulty in duplicating the exact shape of the filter characteristics of the "Brand X" (Milgo) modem.

12. Circuits in the Milgo modem, while it was located in a room in which it was secreted, were used by technicians so that technical drawings could be prepared and used by Rixon for the purpose of copying the Milgo modem (PX 36/11). To conceal the copying efforts, Rixon adopted the code name "Brand X" when referring in written reports to the Milgo modem.

13. Rixon's President Hollis directed his chief engineers to make a "Chinese copy" of the Milgo modem 4400/48 (PX 36/7). Rixon initially designated its copied Milgo modem as the PM-48 modem. Mr. Carl Schroeder was the Rixon engineer in charge of developing the PM-48 modem from August through December of 1968, and he was supplied schematic circuit diagrams of the circuit cards in the Milgo modem. Mr. Schroeder was requested to make the PM-48 modem line-to-line compatible with the Milgo modem. Mr. Schroeder was even reprimanded by his superiors for devoting an undesirable amount of time on his own circuit efforts rather than duplicating the Milgo circuits wire-for-wire.

14. Mr. Andrews, an ex-Rixon employee, who also was involved in the copying process had retained copies of certain particular characteristics of some of the filter curves which were run at Rixon from the "Brand X" Milgo modem after Mr. Andrews left Rixon. Those filter curves were produced and identified at the Andrews' deposition as PX 36/59A through 59H. Those filter curves were verified by Mr. Whang as being those from a Milgo modem.

15. PX 118 is a photograph of one of the analog filters. One filter can is missing, as is shown in the lower right hand corner of the photograph identified as PX 118. Those filter cans were made of a very heavy gauge material and Mr. Whang testified that it was a major operation in order to peel such cans off the Milgo filters. Mr. Schroeder testified that it was the filters which were particularly difficult for Rixon to copy in their attempts to duplicate the shape and characteristics of the Milgo filters. Mr. Schroeder characterized filter design as being a "black art." Rixon tried depotting Milgo's filters. Depotting is very risky and dangerous and according to Mr. Schroeder may well lead to destruction of the filter because the epoxy runs between the wires and the wires may break apart by chipping the epoxy away. Destruction of the "Brand X" Milgo modem in such a chipping process would have brought the copying program to a standstill at Rixon. Damage to the "Brand X" Milgo modem would have meant that Rixon would not have ". . . any reference against which to measure the PM-48 . . . ."

16. Officers of United Telecommunication, Inc. (United) were aware that the PM-48 program was important to Rixon I in trying to compete with Milgo at the time that United agreed to acquire Rixon in October, 1968. United's officers were also aware that the PM-

48 program was considered a crash program by Rixon and 20% of its engineering budget in the PM-48 program was absorbed by it. In December, 1968, after United had agreed to acquire Rixon I, Schroeder prepared a report describing the PM-48 project. The Schroeder report discloses that various components of the "Brand X" modem were used in conjunction with components of the PM-48 to verify the results of the Rixon copying program.

17. Mr. Schroeder left Rixon in December, 1968, because he felt his personal pride degraded as a result of the copying activities. Mr. Schroeder characterized his job activity as "taking somebody else's equipment and basically copying it," and "very unethical."

18. Mr. Dargis another ex-Rixon Engineer was on the Rixon PM-48 Program when he was shown the results of Mr. Stuart's and Mr. Cheney's trip to Kroger to test the Milgo modem. Mr. Dargis was shown a copy of the test results that Rixon ran on the Brand X modem during the trip. (PX 32 pp. 6-8.) The Rixon test report at Kroger is PX 29/7 and it was shown to Dargis by Mr. Stuart who felt that the Milgo Brand X was a good unit. (PX 32, p. 87.) Dargis also knew that Rixon obtained a Milgo Brand X modem which was kept in a closed secret room, and that its circuits were traced by Mr. Andrews and another Rixon employee, John Ditman. (PX 32, pp. 16, 17 and 29.) Dargis was primarily responsible for the digital detector while Mr. Schroeder was in charge of the Rixon PM-48 Program (R. 531).

19. In December, 1968 a breadboard model of the Rixon PM-48 detector had been completed. (PX 32, p. 21.) In order to compare the operation of the PM-48 digital detector with that of Brand X, Dagris ". . . took out the Milgo detector card and used the signals to operate"

the Rixon breadboard. (PX 32 pp. 22-24.) Mr. Dargis wrote a report (PX 29/16) on the comparison of his breadboard detector and the Brand X detector (PX 32 p. 33). The report PX 29/16 is dated January, 1969, and includes a description statement that: "Fig. 2 shows a comparison of the error rate curves obtained with the breadboard PM-48 detector, and it compares those obtained with a Brand X detector. In both cases the Brand X transmitter was the signal source." (PX 29/16 pp. 2, 5.)

20. In January, 1969, the PM-48 detector was still inferior to the Brand X and was in redesign (PX 32, p. 36, PX 29/16 p. 1). Another Rixon employee who had access to the locked secret room, Mr. Skinker, helped Dargis in the later redesign of the Rixon detector. (PX 32, pp. 30, 41.) The first PM-48 modems used a differential detector and were shipped for demonstration in November, 1969. (PX 32, p. 57.) Dargis reviewed the DS-4800 manual and concluded that the detectors were subsequently changed to a coherent detector. (PX 32, pp. 56-58.)

21. At his deposition, Mr. Dargis was shown Fig. 1 of the Ragsdale '381 patent which corresponds to Fig. 5 of the Payne '023 patent and Dargis was asked to compare circuit for circuit the patented Milgo detector with his PM-48 detector as depicted in Dargis' report PX 29/16. Dargis admitted that Fig. 3 of his report "by and large" was similar in circuits and function to Milgo's detector, and that they ". . . definitely would do the same thing." (PX 32, p. 66.) Both the Milgo patent drawings and the Dargis detector Fig. 3 sampled a 7 bit word in the earlier Rixon detector operation. (PX 32, p. 70.) Upon review of the later DS-4800 manual Dargis concluded that it sampled only a three bit word like that shown in Fig. 2 of Ragsdale '381. (PX 39; PX 32, pp. 71, 72.)

22. At his deposition Dargis compared the date on his drawing of January 19, 1969 with the dates of the Ragsdale '381 patent. Dargis concluded both Fig. 1 of the Payne '023 (as shown in Ragsdale '381) and Fig. 3 of his report (PX 29/16, p. 6) ". . . definitely would do the same thing." (PX 32, p. 66.) Dargis further stated: ". . . Also, by looking at the two I notice that this Rixon drawing was made prior to your filing date. So conceivably Milgo copied my drawing." (PX 32, p. 67.)

23. The evidence shows that Rixon I was worried about its copying activities vis-a-vis Milgo's patent rights from the very beginning of Mr. Hollis' "Chinese copy" command to Rixon's chief engineers. Mr. Stuart, at his deposition, identified a letter (PX 29/2) that was written by a Washington, D.C. patent attorney of Rixon to Mr. Wolcott, dated May 16, 1968, that he was not successful in his search of the patent files in finding any Milgo patent assignments because such patent files are not public records. PX 29/2 concludes, ". . . I am afraid their (Milgo) modem patent, if any, cannot be detected until it actually issues." Mr. Stuart at his deposition admitted continuing concern about Milgo's patents. At his deposition (PX 29, pp. 56-57) the following testimony appears:

"Q. Did you ever suggest to anyone at Rixon that they should look into the Milgo patent situation?

"A. Yes, I did.

"Q. When did you make that suggestion?

"A. '69, I guess.

. . . .

"Q. What was the reason for your making that suggestion?

"A. I had been interviewed by Sang and Ed Bleckner and they indicated that they had patents pending on

some of their equipment and I thought it prudent to attempt to be aware of same.

"Q. Did they tell you what the equipment was?

"A. My impression was that it was relative to their Milgo 4800, their nomenclature."

24. The Rixon efforts in copying the Milgo modem continued on from Rixon I through the transition and into Rixon II. On July 2, 1969, Rixon II's modem scientist, Dick Stuart, wrote a memorandum to Vice-President Reed Manning of Rixon II stating that the Milgo people had informed him that they had a patent about to issue on what Stuart called the Rixon PM-48 (PX 29/4). No heed was given this warning by Rixon and it continued the copying effort.

25. PM-48 modems were completed in August, 1969, by Rixon II and were used for demonstration purposes (PX 32, pp. 57-58). The original PM-48 modems used a differential detector as described and claimed in the Payne '023 patent (PX 32, pp. 57-60). These original modems were returned for rework (PX 30, pp. 24, 28 and PX 32, p. 85). Rixon II's next group of copied Milgo modems which were placed on the market in 1970 included the coherent detector described and claimed in the Ragsdale '381 patent (PX 30, pp. 43-44; PX 32, pp. 79-80; and PX 29/18D.) All of the PM-48, PM-48A and DS-4800 modems also incorporated the inventions of the Whang '023 patent.

26. As progress was being made by Rixon in copying Milgo's 2400 bps modem Model 4400/48, Rixon also obtained another Milgo 2400 bps Model 2200/24 that includes the Payne '023 invention in suit. (PX 42, pp. 55-56.)

27. On September 2, 1970, Rixon II's Vice-President Stuart wrote to Rixon II's officer Mercurio and Vice-Presi-

dent Manning that the Whang '023 patent in suit had issued in August, 1970, and that the PM-48 may be infringing. Mr. Stuart recommended that a detailed review be made of the infringing PM-48 (PX 29/5). On September 3, 1970, Rixon's Vice-President Manning wrote to Rixon II's President Horrell and to UBC's President Liepold informing them that the Whang '023 " . . . patent has 40 claims a number of which are embodied in design of the Rixon PM-48. Our first engineering opinion is that we cannot get around all of the patent claims and still design a modem that will be anything like the PM-48 concept." (PX 29/6.)

28. Reed Manning in his September 3, 1970 memorandum to Messrs Horrell and Liepold recommended that Milgo be contacted as soon as possible so that Rixon II could obtain authorization to manufacture the infringing modems. On September 23, 1970, UBC's President Liepold responded to Mr. Manning's memorandum with the directive to Rixon that " . . . it does not seem that we should volunteer to pay any royalties until approached by another company." (PX 77.)

29. After being advised of the infringement of the Whang '023 patent, Rixon II and UBC, without authorization, continued to manufacture and sell the infringing PM-48 and DS-4800 modems. Rixon II continued to manufacture the copied modems under the direction of UBC until the company (Rixon III) was sold to Sangamo Electric Company at the end of September, 1972.

30. According to United's Mr. Deaver, it would have been a prudent business decision to investigate this patent infringement problem. As early as 1968 or 1969, Mr. Stuart at his deposition (PX 29, p. 57, as noted earlier in paragraph 23), also admitted it would be a " . . . prudent matter to be aware . . ." of Milgo's patents. Even with

such patent information in hand, however, UBC/Rixon did not make a real investigation of this serious matter and obtain needed authorization from Milgo. Instead Rixon II and UBC continued to willfully and deliberately manufacture and sell the infringing modems during the time period in suit with reckless disregard of the valid patent rights of Milgo.

31. Defendant UBC induced Rixon II's willful and deliberate infringement by directing Rixon II not to obtain authorization from Milgo for the continued manufacture of the PM-48 and DS-4800 modems after September, 1970. Defendant UBC did knowingly, deliberately, willfully and wantonly infringe the patents in suit for financial gain of UBC and Rixon II.

32. Prior to Milgo's entry into the modem field, the Bell Telephone System was the most prominent manufacturer of modems, while the largest independent manufacturers were Rixon, Collins and Lenkurt.

33. At the damage trial, Mr. Whang, Mr. Toombs and Mr. Bleckner testified that only Rixon and Milgo were viable competitors in the marketplace during the time at issue in this litigation. Defendants' own witness, Mr. Thomas Pool, Vice-President, Communications Systems, United Computing Systems, a subsidiary of United, conducted evaluations beginning in 1970 of 4800 modems and the evaluations indicated that essentialiy only Rixon and Milgo had a viable 4800 bps modem of the type in suit. Mr. Pool helped found United Computing Systems in early 1968. In 1970, he was evaluating several 4800 bps modems for United's use. He evaluated modems made by American Data System (ADS) Model 448, the Bell Systems Model 203, Codex 4800, Collins, Milgo and Rixon. The ADS Model 448, according to defendants' own witness was unacceptable because the error rate was too high.

The Codex Model 4800 bps modems were early production units and exhibited excessive error rates. The Bell Systems' Model 203 failed from an error performance standpoint and Collins never made it through the evaluation.

34. Mr. Pool further testified that the Milgo 4400/48 was initially eliminated from the evaluation, not because of its lack of performance but because Rixon was associated with United at the time and that association "undoubtedly" had a bearing on the decision to select the Rixon modems. Subsequently, after problems on a circuit between Kansas and Denver the Rixon PM-48's would not keep track of data. A Milgo sales representative, in a matter of 24 hours or so, had a couple of Milgo modems for Mr. Pool and cleared up his problem. From that point on, according to Mr. Pool, they primarily used Milgo modems.

35. The Rixon DS-2400 was a competitor to Milgo's 2200/24 for the reason that these two modems did not require C-2 conditioning. Such C-2 conditioning is not only an added monetary requirement to a user but is a nuisance to check and make sure that lines of the telephone company meet the C-2 specification. C-2 conditioning also causes things for the users to worry about that they would certainly like to avoid. In 1972, the Bell 201B did require C-2 conditioning. Therefore, the Bell 201B was not a major contender and only the Milgo 2200/24 and the Rixon DS-2400 would work over the lousy lines without C-2 conditioning. The Lenkurt 2400 bps modem 26C would also not operate over unconditioned lines. Collins, Singer, Telesignal, General Electric, Sangomo, Tel Tech, Penril and Ultronics were listed on defendants' chart (PX 185/Tab IIC) as requiring C-2 conditioning, and thus, were not real competition. Penril and Bomar/ALI, although alleging 2400 bps without C-2 requirements, were newcomers without any established

track record (PX 185/Tab IIC). Modem users and especially large users, such as Burroughs Corp., Honeywell, etc., are conservative customers of modem equipment and will not normally accept suppliers as reliable until they have been in the business for several years. The only accepted sources for 2400 bps modems operating over unconditioned lines during the infringing period were Milgo and Rixon II.

36. When Mr. Robert Toombs, Milgo's Director of Sales, first met with Burroughs in connection with the Burroughs OEM contract, about July, 1970, there were only two competitors being considered for the Burroughs contract. Those competitors were Lenkurt and Milgo. Lenkurt at that time only had a 2400 bps modem and did not have a 4800 bps modem. The Lenkurt 2400 bps modem was not real viable competition in this initial stage because the Lenkurt data set did not operate over unconditioned lines. Lenkurt was subsequently eliminated from the Burroughs negotiations.

37. In approximately late September through November, 1970, Burroughs first considered Rixon's infringing modems, and it was about that time that Burroughs indicated that the OEM requirements included not only a 2400 bps modem but a 4800 bps modem. Burroughs was interested in the 4800 bps modem because they were looking to future needs, while the 2400 bps modem was their current need.

38. Plaintiff's Exhibit 189 is a summary of Mr. Robert Toombs activities concerning the Burroughs order dated November, 1970. Lenkurt had been dropped as expected, but Rixon had suddenly entered as Milgo's competition. One technical feature presented by Rixon was that the Rixon unit had forward equalization for a multipoint sys-

tem and it was line-to-line compatible with the Milgo 4400/48 from which it had been copied. In November, 1970, only Rixon and Milgo were the sources being considered for the 4800 bps modem by Burroughs. The Bell Telephone Company was not in the running for the Burroughs order. At that time, point-to-point was a familiar and common type operation for many 2400 bps modems. However, until Milgo's pioneer modem breakthrough of an acceptable 4800 bps modem, users, such as Burroughs, had not given thought to multipoint systems at 4800 bps.

39. Mr. Toombs, on behalf of Milgo, offered to Burroughs a device bearing the nomenclature Milgo Model 4400/48B, the letter "B" reflected the fact that Milgo already had proven and in existence its own forward equalization capability that would satisfy multipoint operation. At the time that the offer to Burroughs was made, the equalizing equipment for multipoint operation had been reduced to practice by Milgo in connection with its 4600/48 project, which was an ongoing Research and Development project taking place at Milgo. Toombs was able to cost and price out the equalizer because such forward equalizing circuitry was in existence at Milgo. Milgo submitted its 4400/48 and 2200/24 modems to Burroughs for Burroughs' own engineering people to test. Burroughs did exhaustive tests of a non-destructive type. They examined Milgo's equipment in detail.

40. In Mr. Toombs experience for OEM contracts, Mr. Toombs confirmed that it is quite usual for an OEM contractor to want minor modifications to the modem circuitry or the packaging to meet the particular needs of different OEM customers. In Mr. Toombs opinion, had the Rixon Sebit 48 been the only available modem that Rixon could have submitted to Burroughs, Rixon would never have been in the running for the Burroughs multiyear contract.

41. Exhibit No. 190 is a pricing letter from Mr. Toombs dated January 4, 1971, which quoted prices for the basic 4400/48 bps modem, with one equalizer, which was Milgo's stock 4400/48 modem. The price was about $3220, which was the sum of $2910 for the modem 4400/48 and $310 for accessories. Another typical price submitted by Milgo for the 2400 bps unit to Burroughs was $1690.

42. Plaintiff's Exhibit No. 191 reflected a change in the price that Milgo was offering to Burroughs for the comparable modem, that change in price was caused by Rixon's offering to Burroughs of a lower priced comparable unit. Plaintiff's Exhibit No. 192 reflected further negotiations between Burroughs and Milgo and confirmed additional costs to Burroughs for the forward plug-in equalizer.

43. Milgo's prices quoted to Burroughs on the OEM contract for modems were undercut by 10% through 37% by Rixon.

44. Honeywell placed a large order for modems during the infringing time period in issue. Although Mr. Toombs did not participate in negotiations between Honeywell and Milgo, he was familiar because of his sales oriented marketing positions in Milgo with the OEM contacts between Honeywell and Milgo in the 1970-71 time frame. Mr. Toombs testified that Milgo had sold during the 1970-71 time frame, Milgo Models 3300/36 to Honeywell. Rixon sold its DS-2400 modems to Honeywell. Those infringing modems were in competition with Milgo's 2200/24. Mr. Toombs excluded Lenkurt from being in consideration during that time period because the Lenkurt duobinary technique would not work on unconditioned lines. Mr. Toombs excluded Penril as a fledgling newcomer. Codex did not even have a 2400 bps modem. Honeywell, therefore, would have been interested only in Milgo or Rixon.

45. The foregoing findings concerning Burroughs and Honeywell establish that only Rixon and Milgo were viable sources for 2400 bps modems which worked satisfactory over unconditioned lines and for the narrow bandwidth 4800 bps modems in suit. Mr. Pool confirmed that United Computing Systems considered Milgo and Rixon as viable sources. The Rixon sales to the United States Government have been eliminated from this accounting. A review of the computer printout establishes that when these four major customers of Rixon/UBC (Burroughs, Honeywell, United Computing Systems and the United States Government) have been considered, there remains only a small number of customers involving a limited number of modems. Some of these smaller Rixon/UBC customers included many that Milgo had sales contacts with. Such customers include University Computing Co., Federal Mogul, Panhandle Eastern, Allstate, and Medical Data Systems. Mr. Bleckner confirmed that to the best of his knowledge Milgo was in competition with Rixon/UBC for all of Rixon/UBC's customers.

46. The records pertaining to the number of infringing modems made, used, leased or sold by Rixon II and/or UBC are incomplete due at least in part to the transfer of Rixon II's assets and accounting documents to Rixon II in September, 1972. The records that do exist indicate that an initial 20 infringing 4800 bps modems were made in 1969 and returned in whole or in part to Rixon II in 1970 for refurbishing and resale or lease (PX 30, pp. 8-9, 178). According to Mr. Relyea's testimony, Rixon II did not begin to supply the infringing modems commercially until July, 1970. Therefore, in all reasonable probability, the original 20 modems were transferred to UBC prior to August 11, 1970, resold or leased by UBC after August 11, 1970. The records further show that a couple

of hundred serial numbers assigned by Rixon II to the infringing modems could not be accounted for. Furthermore, Rixon assigned the same serial numbers to more than one modem in many cases. The records further do not reflect how many job orders were issued or the total number of modems actually manufactured by Rixon.

47. Milgo initially contended, through Mr. Swan's testimony, that Rixon/UBC together delivered a total of 636 infringing 4800 bps modems. The parties were in disagreement concerning inventory transfers, double counting, duplication of serial numbers and differences in actual numbers of inventory transferred between Rixon II and UBC, UBC back to Rixon II and Rixon II to Rixon III. After reviewing all the evidence, the Court finds that a minimum number of 178 infringing 4800 bps modems were leased or sold during the time period in issue, not including 150 modems sold to the United States.

48. The exact number of infringing modems manufactured by Rixon II is very difficult to ascertain because of the incompleteness of the records. Mr. Relyea, the Controller for Rixon II, testified that from his review of the incomplete records, he determined that 377 infringing 4800 bps modems were manufactured by Rixon II from August 11, 1970 to August 31, 1972. When the initial 20 infringing modems referred to by Koester is added to this, the result is 397 modems. Assuming that only 40 infringing modems were manufactured by Rixon II during September, 1972, then the resultant figure is 437 infringing modems which were manufactured, used or sold by the defendant UBC or its subsidiary Rixon II during the term of the Whang '023 patent. We are nevertheless limiting the number of infringing 4800 bps devices leased or sold by defendant during the period from July 19, 1971 through September 30, 1972.

49. Milgo's normal leasing procedure recoups as a minimum at least the amount that Milgo makes on its outright sales for 4800 and 2400 bps modems. In the industry, it is customary to account for leases as sales during the relevant time period. All shipments whether a sale or lease by the defendant during the relevant time period are treated as a sale for the purpose of calculating what profit Milgo would have made had Milgo made the shipments instead of UBC or Rixon II.

50. The infringing modems amount to about 6% of Milgo's total modem sales for the years involved. Mr. Bleckner's testimony was that Milgo had the capability of making these increased sales and that such an increase in Milgo's sales would not have required any increase in the general and administrative (G&A) expenses for the parent corporation, Milgo. Mr. Bleckner's testimony was also that Milgo would not have increased its research and development budget for the years in question by reason of such increased sales. The contribution to Milgo's profit by its modem line is established by reports (10K's) prepared each year for filing with the Securities and Exchange Commission (PX 208). Mr. Swan used these reports and certain Milgo accounting reports (PX 210 or PX 211) to compute the contribution to Milgo's profit for the additional modems it would have shipped but for the infringement. This computation amounts to a 43.4 average profit margin for the years 1970-1972 which computation did not include Milgo's G&A or R&D expenses for the year in question (PX 209 or PX 221). This computation is reasonable in view of the fact that the small increase in sales (6%) would not have required any additional Milgo G&A or R&D expenses (PX 221 or PX 209).

51. From the evidence, in calculating the damages caused by the infringing 2400 bps modems of which there

were 338 from and after the date of July 28, 1972, when the existence of the patent and knowledge of the infringement became known with certainty to defendant, the lost profit of plaintiff on each unit was $710.00, making a total of $239,980.00.

52. From the evidence, in calculating the damages caused by infringing 4800 modems, 178 of these infringing modems were leased or sold by defendant from and after July 19, 1971, the date the original suit was filed relating to the Whang '023 patent of 4800 modems. The lost profit per unit on the infringing modems in the amount of $2,-146.00 each, equals $381,988.00.

53. The lost profits of Milgo for the actual shipments of the infringing modems made by UBC or Rixon II is calculated by (1) multiplying Milgo's average sales price for the comparable patented modems (4800 bps or 2400 bps) by Milgo's average contribution to profit of 43.4% for the years 1970-1972 to obtain the unit profit margin and (2) multiplying the unit profit margin by the number of infringing modems shipped. Milgo's average sales prices for the comparable patented modems are set forth on PX 222 or PX 212 for the years in question. The unit profit margin is set forth on PX 222 or PX 212.

54. The Court finds that the evidence does not sustain proof of damages claimed by plaintiff for lost potential future orders, follow up or "add on" orders.

55. At the damages trial, it was established that the name of the plaintiff has been changed from Milgo Electronic Corporation to Racal-Milgo, Incorporated.

56. This case is exceptional within the meaning of 35 U.S.C., and the Court awards plaintiff's attorneys' fees.

The Court finds from the evidence, considering the length of time involved and the complexity of the litiga-

tion, that reasonable attorneys' fees should be awarded to plaintiff in the amount of $250,000.00.

57. A reasonable interest rate for the period of 1972-77 is 7 1/2%.

58. Milgo is awarded interest of 7 1/2% on $621,-968.00 compounded annually from 1972.

59. Each Finding of Fact set forth in the foregoing Findings of Fact deemed to be a Conclusion of Law is hereby found to be a Conclusion.

From the foregoing Findings of Fact, the Court reaches the following:

CONCLUSIONS OF LAW

1. This Court has jurisdiction over the parties and over the subject matter of the suit. Venue is properly laid in this District.

2. Milgo is entitled to damages for the infringement by Rixon II and UBC. 35 U.S.C.A. §§ 283 through 287.

3. Defendant is liable for infringement from July 19, 1971 (the date suit was filed and process served) through September 30, 1972, for actual deliveries of the PM-48, PM-48A and DS-4800 data sets by Rixon II or UBC.

4. Defendant is liable for damages caused by actual deliveries of the DS-2400 data sets from July 28, 1972 through September 30, 1972 (the date of transfer of Rixon II to Rixon III), by Rixon II or UBC.

5. Milgo is entitled to recover damages as to the sales which it would have made but for the infringement, based on the entire profit which Milgo would have received from such sales. Under the circumstances, Milgo is

awarded its lost profits on all deliveries (sales or leases) by defendant. *Ingersoll-Rand v. Brunner & Lay*, 182 U.S.P.Q. 257; *National Reflectors v. A.B.T. Mfg. Corp.*, 188 F.2d 706 (7th Cir. 1951); *Livesay Window Co. v. Livesay Industries*, 251 F.2d 496 (5th Cir. 1958).

6. Where the wrong done Milgo in this case is so absolute, the consequences of any inability to demonstrate Milgo's loss with scientific accuracy is a burden that must be met by the infringer. *Livesay*, supra; *H. K. Porter Co., Inc. v. Goodyear Tire & Rubber Co.*, 536 F.2d 1115 (6th Cir. 1976). All doubts occasioned by Rixon/UBC's failure to keep proper records are to be resolved in favor of Milgo. *Georgia Pacific Corp. v. United States Plywood Corp.*, 243 F.Supp. 500, 509 (S.D.N.Y. 1965); *American Sterilizer v. Sybron Corp.*, 526 F.2d 542, 548-549 (3d Cir. 1975).

7. The award of damages for loss by Milgo of sales and leases of the patented modems copied by the defendant is proper, even though the defendant may not have made any profit of its own on the sale and lease of the infringing modems. *Yale Lock Mfg. Co. v. Sargent*, 117 U.S. 536 (1885).

8. In view of defendant's willful and deliberate infringement and the unusual lengths to which defendant went in copying Milgo's inventions, this is an exceptional case. In such circumstances, Milgo is entitled to treble damages, costs, expenses and attorneys' fees because defendant has knowingly, deliberately, willfully and wantonly infringed the patents. 35 U.S.C.A. §§ 271 through 287. *Maxon Premix Burner Co. v. Mid-Continent Metal Prod. Co.*, 279 F.Supp. 164 (N.D.Ill. 1967).

9. Milgo is entitled to an award of interest on its damages sustained as a result of the infringement. See

Georgia Pacific, supra. A reasonable interest rate in this case is 7 1/2%. See *Textronic, Inc. v. United States*, 552 F.2d 343, 352-53 (Ct.Cl. 1977).

10. The plaintiff in this suit is now Recal-Milgo, Incorporated, formerly Milgo Electronic Corporation.

11. Each Conclusion of Law set forth in the foregoing Conclusions of Law deemed to be a Finding of Fact is hereby found to be a Finding of Fact.

Plaintiff's counsel will promptly prepare, circulate and submit form of judgment to be entered.

Dated at Topeka, Kansas, this 7th day of April, 1978.

ORDER MODIFYING AND SUPPLEMENTING FINDINGS OF FACT AND CONCLUSIONS OF LAW

(Filed May 23, 1978)

The Court has heretofore prepared and filed on April 7, 1978, its Findings of Fact and Conclusions of Law. Thereafter, plaintiff prepared and circulated a proposed form of Judgment. This form suggested by plaintiff was objected to by defendant in several respects.

The matter was set down for hearing before the Court. Both parties filed briefs and, in addition, presented oral arguments. The Court took the matter under advisement and after considerable research concludes that some of the Findings and Conclusions should be modified consistent with established law and rules of patent law, as follows:

Finding No. 57 should be modified to read as follows:

"57. A reasonable interest rate for the period from September 30, 1972, the date on which the last infringement

by defendant and those acting in concert with it occurred, is 6%. The infringement was knowingly, willfully and intentionally continued from the date plaintiff's complaint was filed on July 19, 1971. There is in this case exceptional circumstances which are set forth in these Findings and which justify a departure from the general rule that interest on damages are not allowed until the damages are liquidated. *Duplate Corp. v. Triplex Co.*, 298 U.S. 448. Plaintiff here is entitled to an allowance of prejudgment interest."

Finding No. 58 should be modified to read as follows:

"58. Milgo is awarded interest of 6% on $621,968.00, not compounded, beginning September 30, 1972, and running to the date judgment is entered, calculated at $102.24 per day."

The Court further finds that some of the Conclusions of Law announced by the Court should be amended or modified as follows:

Conclusion No. 3 should be amended to read:

"3. Defendant is liable for prejudgment interest on the actual damages suffered by plaintiff because of the infringement from the date of the last infringement until the date judgment is entered at the rate of 6%."

Conclusion No. 9 is amended to read:

"9. Milgo is entitled to an award of prejudgment interest on its actual damages sustained as a result of the infringement. A reasonable rate in this case is the Kansas statutory rate of 6%. From and after the date on which judgment is entered, the judgment for compensatory damages, which includes interest to date of judgment, in the amount of $832,380.58, shall bear interest, not compounded, at the rate of 8% (K.S.A. 16-204), until paid."

The foregoing amendments and modifications of Findings and Conclusions are now declared to be amendatory and supplemental to the Findings and Conclusions heretofore filed in this proceeding.

Dated at Topeka, Kansas, this 23rd day of May, 1978.

JOURNAL ENTRY OF JUDGMENT

(Filed May 23, 1978)

Pursuant to the direction of this Court dated January 13, 1976 on the issue of validity and infringement and on the 7th day of April, 1978 on the issue of willfulness and damages,

IT IS HEREBY ORDERED AND ADJUDGED:

1. The Court has jurisdiction over the subject matter of this civil action and over the parties hereto. The parties hereto include plaintiff, Milgo Electronic Corporation (Milgo), which is now known as Racal-Milgo, Inc. The defendants include United Telecommunications, Inc. (UTI) and United Business Communications, Inc. (UBC).

2. Plaintiff owns the entire right, title and interest, including the right to sue for past infringement of U. S. Patent No. 3,524,023 (Whang '023 patent), U. S. Patent No. 3,590,381 (Ragsdale '381 patent) and U. S. Patent No. 3,643,023 (Payne '023 patent).

3. The Whang '023, the Ragsdale '381 and the Payne '023 patents are valid and infringed by UBC and by its subsidiary Rixon Electronics, Inc. (Rixon II). Rixon II, through the accounting period ending September 30, 1972 was the mere instrumentality, alter ego or agent of UBC.

4. United Telecommunications, Inc., has not infringed or actively induced infringement of the Whang '023, Ragsdale '381 or Payne '023 patents, and Rixon II was not the mere instrumentality, alter ego or agent of United Telecommunications, Inc., at any time after August 11, 1970. The complaint of infringement against United Telecommunications, Inc., is dismissed.

5. Defendant United Business Communications, Inc., and its officers, agents, servants, employees, and those persons, companies or corporations in actual concert or participation with it are forbidden and enjoined from making, leasing or selling data sets known variously as PM-48A, DS-4800, DS-2400, or any other data sets which infringe the Whang '023, Ragsdale '381 or Payne '023 patents.

6. Plaintiff is awarded damages equal to its lost profits from July 1, 1971 to September 30, 1972 in the amount of $621,968.00, plus interest, not compounded, computed at a rate of 6 percent per annum to the date of this judgment. As of May 23, 1978, the total interest, calculated at $102.24 per day, on said $621,968.00 is $210,412.58. This last figure represents prejudgment interest at 6 percent per annum from and after the date of the last infringement, i.e., September 30, 1972, and constitutes additional compensatory damages in the form of moratory interest on the plaintiff's lost profits.

7. The lost profits specified in paragraph 6 in the amount of $621,968.00 are to be trebled pursuant to 35 U.S.C. §284.

8. Interest, not compounded, shall run on the compensatory damages in the amount of $832,380.58, which includes plaintiff's lost profits and the compensatory prejudgment interest from the date of judgment at a rate of 8 percent per annum.

9. Plaintiff is entitled to reasonable attorneys' fees of $250,000.00.

10. Plaintiff is entitled to recover its taxable costs in the amount of $14,409.65.

11. Judgment is entered herein to plaintiff for $2,076,316.58, plus $250,000.00, allowed for attorneys' fees, together with interest and costs as herein provided.

Dated at Topeka, Kansas, this 23rd day of May, 1978.

ORDER AMENDING AND CORRECTING JUDGMENT AND ENTERING AMENDED JUDGMENT

(Filed June 13, 1978)

On May 23, 1978, the Court prepared and entered a Journal Entry of Judgment based upon Findings and Conclusions, as amended. The judgment so entered provided that plaintiff should have and recover damages equal to its lost profits in the amount of $621,968.00, plus interest, not compounded, computed at the rate of 6 percent per annum to the date of the judgment. The amount of the prejudgment interest to date of May 23, 1978, calculated at $102.24 per day, amounted to $210,412.58, for the period beginning September 30, 1972, the date of the last infringement by defendant and constituted additional compensatory damages in the form of moratory interest on plaintiff's lost profits.

The Court further granted judgment trebling the lost profits of $621,968.00 in the amount of $1,865,904.00.

The judgment provided that post-judgment interest should only run on compensatory damages and not on attorneys' fees, costs awarded plaintiff and the trebled portion of plaintiff's damages.

Plaintiff has filed a motion pursuant to F.R.Civ.P. 59(e) requesting an order altering or amending the judgment entered on May 23, 1978, to provide that the entire money judgment awarded it bear simple interest at the rate of 8 percent per annum as provided by Title 28, U.S.C. § 1961, and K.S.A. (Kansas Statutes Annotated) 16-204, until paid.

The Court has been supplied with a memorandum by each of the parties. The issue raised involves the application of the statute providing for the allowance of interest on judgment entered in patent infringement cases.

Defendants insist that the motion should be denied for the reason that Title 35 U.S.C. § 284 provides that the matter of fixing interest and taxing costs is within the trial court's discretion. The statute reads:

> "Upon finding for the claimant the court shall award the claimant damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs *as fixed by the court.*" [Emphasis supplied.]

On the other hand, plaintiffs call to the Court's attention the provisions of Title 28 U.S.C. § 1961 which governs awards of post-judgment interest in United States District Courts and which provides, in pertinent part, as follows:

> "Interest shall be allowed on any money judgment in a civil case recovered in a district court . . . Such interest shall be calculated from the date of entry of the judgment, at the rate allowed by State law."

After careful review and consideration of the statutes involved, the Court is persuaded that Title 35 U.S.C. § 284 has application to awards of prejudgment interest and

is not in conflict with Title 28 U.S.C. § 1961 which provides in positive terms, with no exceptions, for post-judgment interest on the total amount of money judgment from the date of its entry.

The Court, therefore, must sustain plaintiff's motion and Conclusion of Law No. 9 as set forth in the Court's Order Modifying and Supplementing Findings of Fact and Conclusions of Law, filed May 23, 1978, is amended to read as follows:

> "Milgo is entitled to simple interest on the entire money judgment from May 23, 1978, in the amount of $2,340,726.23, at the rate of 8 percent per annum, as provided by K.S.A. 16-204, until paid."

The judgment entered herein on May 23, 1978, is amended and corrected to read as follows:

1. The Court has jurisdiction over the subject matter of this civil action and over the parties hereto. The parties hereto include plaintiff, Milgo Electronic Corporation (Milgo), which is now known as Racal-Milgo, Inc. The defendants include United Telecommunications, Inc. (UTI) and United Business Communications, Inc. (UBC).

2. Plaintiff owns the entire right, title and interest, including the right to sue for past infringement of U. S. Patent No. 3,524,023 (Whang '023 patent), U. S. Patent No. 3,590,381 (Ragsdale '381 patent) and U. S. Patent No. 3,643,023 (Payne '023 patent).

3. The Whang '023, the Ragsdale '381 and the Payne '023 patents are valid and infringed by UBC and by its subsidiary Rixon Electronics, Inc. (Rixon II). Rixon II, through the accounting period ending September 30, 1972, was the mere instrumentality, alter ego or agent of UBC.

4. United Telecommunications, Inc., has not infringed or actively induced infringement of the Whang '023, Ragsdale '381 or Payne '023 patents, and Rixon II was not the mere instrumentality, alter ego or agent of United Telecommunications, Inc., at any time after August 11, 1970. The complaint of infringement against United Telecommunications, Inc., is dismissed.

5. Defendant United Business Communications, Inc., and its officers, agents, servants, employees, and those persons, companies or corporations in actual concert or participation with it are forbidden and enjoined from making, leasing or selling data sets known variously as PM-48A, DS-4800, DS-2400, or any other data sets which infringe the Whang '023, Ragsdale '381 or Payne '023 patents.

6. Plaintiff is awarded damages equal to its lost profits from July 19, 1971 to September 30, 1972, in the amount of $621,968.00, plus interest, not compounded, computed at a rate of 6 percent per annum to the date of this judgment. As of May 23, 1978, the total interest, calculated at $102.24 per day, on said $621,968.00 is $210,412.58. This last figure represents prejudgment interest at 6 percent per annum from and after the date of the last infringement, i.e., September 30, 1972, and constitutes additional compensatory damages in the form of moratory interest on the plaintiff's lost profits.

7. The lost profits specified in paragraph 6 in the amount of $621,968.00 are to be trebled pursuant to 35 U.S.C. § 284.

8. Plaintiff is entitled to reasonable attorneys' fees of $250,000.00.

9. Plaintiff is entitled to recover its taxable costs in the amount of $14,409.65.

10. Pursuant to 28 U.S.C. § 1961, post-judgment interest not compounded, shall run on the judgment in the amount of $2,340,726.23, which includes the plaintiff's actual and trebled damages, as well as prejudgment interest, attorneys' fees and costs, from the date of judgment at a rate of 8 percent per annum.

11. Judgment is entered herein to plaintiff for $2,340,726.23.

Dated at Topeka, Kansas, this 13th day of June, 1978.

A161

INTER-UNIVERSITY ELECTRONICS SERIES, VOL. 2

DATA TRANSMISSION

WILLIAM R. BENNETT

Head, Data Theory Department
Bell Telephone Laboratories, Incorporated

JAMES R. DAVEY

Head, Data Terminals and Transmission Department
Bell Telephone Laboratories, Incorporated

McGRAW-HILL BOOK COMPANY

New York San Francisco Toronto London Sydney

CHAPTER 10

PHASE-MODULATION SYSTEMS

Phase-modulation systems for transmission of digital data usually show more resemblance to AM systems than to FM systems. As previously mentioned, a phase change of $+180°$ cannot be differentiated from a change of $-180°$ unless it takes place slowly enough to indicate the direction of change. For the transmission of a continuous analog quantity, phase changes of any amount could conceivably be used. The signal would be equivalent to an FM wave having an instantaneous frequency equal to the time derivative of the phase. The modulating wave could be recovered by integrating the output of a frequency detector. For digital data, where it is desirable to handle a baseband extending to zero frequency, a direct phase detector is preferable, and only the phase at particular instants of time is of importance. The useful range of phase change then becomes $\pm 180°$. Such a signal can be expressed as two double-sideband AM signals at quadrature carrier phase. Indeed such signals are often generated and detected as composite AM signals.

As brought out before, amplitude modulation of a carrier by a polar baseband wave results in plus and minus amplitudes which are the same as carrier phase reversals. Binary phase modulation for optimum results would employ $180°$ changes and thus would be identical to the case of binary AM with carrier suppressed as covered in Chap. 8. Consequently, we will mainly consider here the case in which there are more than two states and hence more than one bit of information in each Nyquist interval. Since the input and output of a multiphase data system are commonly binary data, it is usual to have the number of phase conditions equal to an integral power of two, such as four or eight to keep the translation simple. With four phases, each interval or symbol carries two bits of information; and with eight phases, each interval carries three bits. Complementary serial-to-parallel and parallel-to-serial conversions are performed at the transmitter and receiver respectively. As in the case of multilevel amplitudes, the Gray code is usually chosen because of fewer bit errors than with natural binary code.

10-1 GENERATION OF PHASE-MODULATION SIGNALS

Figure 10-1 shows how a four-phase signal can be generated by combining two AM waves in quadrature. The binary digits to be transmitted are grouped in pairs. We will designate the first digit in a pair by A and the second digit by B. These A and B digits in polar form are applied simultaneously to linear amplitude modulators. The A modulator is fed with 0° carrier and the B modulator with 90° carrier. The A modulator output consists of 0° carrier when the A digit is a "1" and 180° carrier when the A digit is a "0." Similarly the output of modulator B is a plus or minus 90° carrier depending upon whether B is 1 or 0. The modulator outputs are summed to give a four-phase signal. The four possible output phases and their AB-digit combinations are shown in Fig. 10-1. It will be noticed that the two-digit combinations are arranged in a cyclic code so that adjacent steps differ in but one digit. Adjacent codes are separated by 90°.

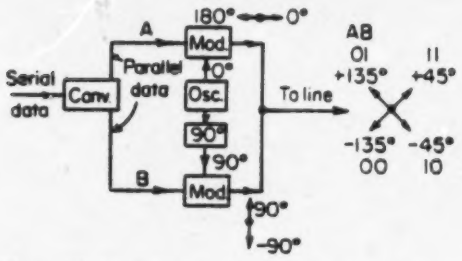


FIG. 10-1. Generation of a four-phase signal.

In Fig. 10-2 the same general technique is shown expanded to produce an eight-phase signal. In this case the binary digits are grouped in threes, A, B, and C. The third digit C is used to modulate the polar

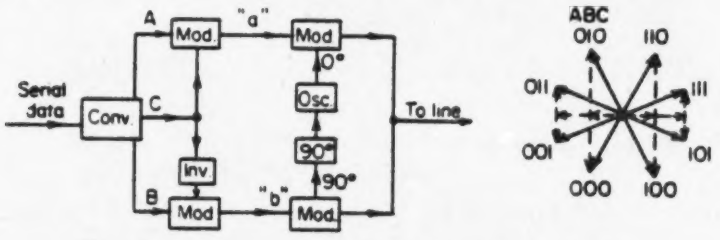


FIG. 10-2. Generation of an eight-phase signal.

A and B digits differentially. The baseband waves at points a and b have four levels, two positive and two negative. When C is a 1, the amplitude of a is greater than that of b. For C a 0, the opposite is true. The four-level polar signals at a and b are used to modulate quadrature carriers as in the four-phase case. The effect of the differential modulation by digit C is of such magnitude as to cause a $\pm 22.5°$ shift in the phase of the combined output thus giving a total of eight phases spaced 45° apart. The phase positions and their three binary digit

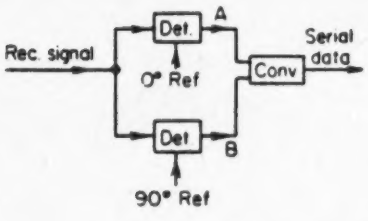
designations are shown in the right-hand part of Fig. 10-2. Here again a cyclic code is obtained.

Another possible method of generating a multiphase signal uses phase-shifting networks to obtain sources of each desired phase. Appropriate digital logic and gating circuitry then selects the phase according to the binary combinations of the input data. Still another method generates the various phases by frequency dividing the output of an oscillator running at a multiple of the desired carrier frequency. For example, 45° phase intervals can be obtained by dividing by eight. Proper presetting of the dividing circuitry enables selection of any specific 45° phase.

The signal waves produced by the arrangements of Figs. 10-1 and 10-2 do not have constant amplitude and therefore are not pure phase-modulated signals. However, all restricted-bandwidth angle-modulated signals exhibit AM.

10-2 FIXED-REFERENCE PHASE DETECTION

The changing phase pattern of the signals described in Sec. 10-1 can be detected by comparing the received phase with that of a fixed



Input phase	Binary code (AB)	A 0° detection	B 90° detection
−45°	11	−	−
−45°	10	−	−
−135°	01	−	−
−135°	00	−	−

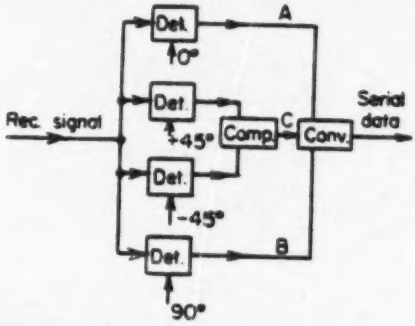
FIG. 10-3. Fixed reference detection of a four-phase signal.

reference phase. We will assume for the present that such a reference is available. In Chap. 8 the use of a product modulator was described for detecting AM signals. It was shown to give an output proportional to the signal component in phase with the reference carrier. The output thus varies as the cosine of the angle between the input and the reference carrier and can therefore be used as a phase detector.

Figure 10-3 illustrates a receiver for four-phase signals utilizing a fixed reference. The incoming phases are $\pm 45°$ and $\pm 135°$. The received signal is applied to two product modulators driven by reference phases of 0° and 90°. The table in Fig. 10-3 shows the relationship between the input phases, their digital assignments, and the polarity of the detector outputs. The 0° reference is seen to detect the A digit, and the 90° reference to detect the B digit. Such a four-phase system

as described here is identical to two AM channels operating at quadrature phase to avoid mutual interference. The reference carrier phases correspond to the original carrier phases used in the modulators at the transmitter.

A similar receiving arrangement for eight phases is shown in Fig. 10-4. Here the received signal is assumed to be as generated in Fig. 10-2. It is applied to four product modulators fed with reference carrier at 0°, 90°, and ±45°. The table again shows the relationship



Input phase	Binary code	*A* 0°	*B* 90°	*C*	
				+45°	−45°
−22.5°	111	−	−	+	+
−67.5°	110	−	+	+	−
−112.5°	010	−	+	−	−
−157.5°	011	−	+	−	−
−157.5°	001	−	−	−	−
−112.5°	000	−	−	−	+
−67.5°	100	−	−	−	+
−22.5°	101	−	−	+	+

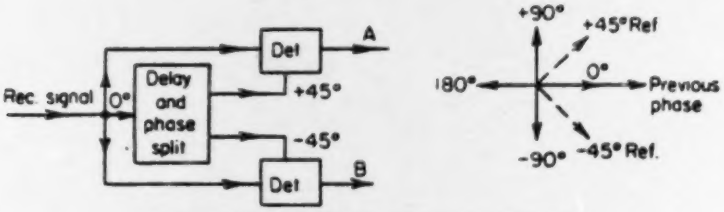
FIG. 10-4. Fixed reference detection of an eight-phase signal.

between the input phases, their binary assignment, and the polarity of the modulator outputs. The 0° reference detects the *A* digit. The 90° reference detects the *B* digit. The *C* digit can be determined by comparing the results obtained with the ±45° references. Like polarities indicate a "1" and unlike polarities a "0." The *C* digit could also be determined from the relative amplitudes of the 0° and 90° detectors, but the use of the ±45° detectors enables the decision to be made by polarity only and is thus insensitive to amplitude variation.

10-3 DIFFERENTIAL PHASE DETECTION

As will be described later, a fixed reference can under certain conditions be maintained from a random sequence of phase-modulated symbols. The receiver has no sense of absolute phase, however, and

must be given some initial indication of the correct reference. Because of the difficulties of establishing and maintaining the correct reference phase, it is common practice to encode the information in terms of phase changes and to detect the signal by comparing phases of adjacent symbols. This is often called differential phase detection. For optimum margin against noise, the changes are chosen to space the choices of symbol phase evenly over 360°. In the case of a binary system, the choices should be 180° apart. Phase changes of 0° and 180° or of +90° and −90° are possible choices. In the case of a

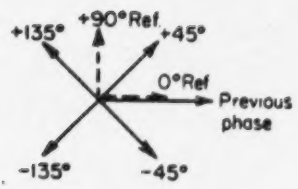


Phase change	Binary code	A −45°	B −45°
0°	11	—	—
+90°	10	—	—
180°	00	—	—
−90°	01	—	—

FIG. 10-5. Differential phase detection of a four-phase signal having changes of 0°, ±90°, and 180°.

quaternary system, the phase changes can be 0°, −90°, −90°, and 180°. The arrangement of Fig. 10-1 together with the proper digital logic to feed the modulators can be used to generate such a signal. It is sometimes desirable to avoid a 0° change by employing phase shifts of ±45° and ±135° for the four possible changes. A total of eight line phases are produced with such changes. Such a signal could be produced by the arrangement of Fig. 10-2 with the proper logical control.

A method of differential phase detection for phase changes of 0°, ±90°, and 180° is shown in Fig. 10-5. The received signal is applied to a broadband delay and phase-splitting network having two outputs with one shifted −45° and the other −45° in phase relative to the input at the carrier frequency. In addition the network has a time delay of one symbol interval. Product demodulators or phase detectors compare the phase at the outputs of the network with that at the input. A vector diagram is given in Fig. 10-5 showing the phase relationships of the previous symbol, the four possible states of the present symbol,

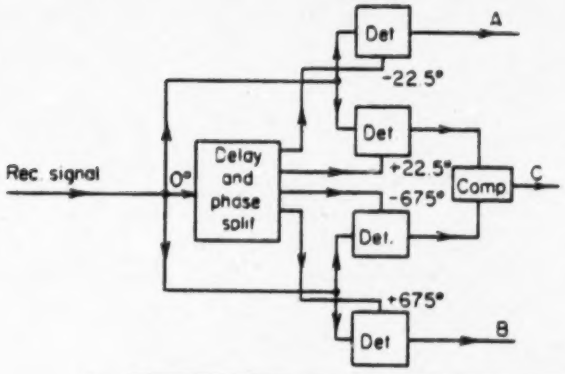


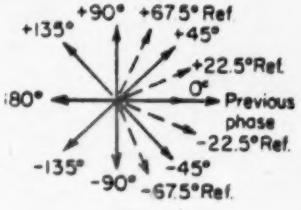
Phase change	Binary code	*A* 0°	*B* +90°
−45°	11	+	+
−135°	01	−	+
−135°	00	−	−
−45°	10	+	−

FIG. 10-6. Differential phase detection of a four-phase signal having changes of ±45° and ±135°.

and the two references from the delay network. The table gives the polarities of the demodulator outputs for the four possible phase changes. Also shown are possible binary designations for these changes which result in the demodulator outputs directly representing the *A* and *B* digits, thus eliminating the need of any code translation. The vector diagram and table of Fig. 10-6 show how phase changes of ±45° and ±135° can be detected in a similar manner by having the delay network references at 0° and −90°.

The same technique as applied to an octonary signal is shown in Fig. 10-7. Here phase changes of 0°, ±45°, ±90°, ±135°, and 180°

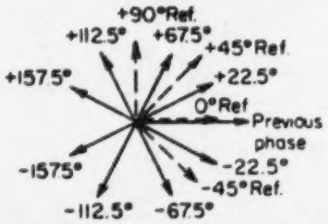




Phase change	Binary code	*A* −22.5°	*B* −67.5°	*C*	
				−22.5°	−67.5°
0°	111	−	−	−	−
−45°	110	−	−	−	−
−90°	010	−	−	−	−
−135°	011	−	−	−	−
180°	001	−	−	−	−
−135°	000	−	−	−	−
−90°	100	−	−	−	−
−45°	101	−	−	−	−

FIG. 10-7. Differential phase detection of an eight-phase signal having changes of 0°, ±45°, ±135°, and 180°.

are assumed. The delay and phase-splitting network provides references at $\pm 22.5°$ and $\pm 67.5°$. Four product demodulators are used. The table gives the demodulator output polarities for each of the eight possible phase changes. For the binary designations indicated, it is seen that the $-22.5°$ reference selects the A digit, the $\pm 67.5°$ reference the B digit, and a comparison of the likeness of the outputs from the $-67.5°$ and $+22.5°$ detectors gives the C digit. If phase changes of



Phase change	Binary code	A $0°$	B $+90°$	C	
				$-45°$	$-45°$
$-22.5°$	111	−	+	+	−
$-67.5°$	110	−	+	+	−
$-112.5°$	010	−	−	+	−
$-157.5°$	011	−	+	−	−
$-157.5°$	001	−	−	−	−
$-112.5°$	000	−	−	−	−
$-67.5°$	100	−	−	−	−
$-22.5°$	101	−	−	−	−

FIG. 10-8. Differential phase detection of an eight-phase signal having changes of $\pm 22.5°$, $\pm 67.5°$, $\pm 112.5°$, and $\pm 157.5°$.

$\pm 22.5°$, $\pm 67.5°$, $\pm 112.5°$, and $\pm 157.5°$ were used for the eight possibilities, references at $-45°$, $0°$, $+45°$, and $\pm 90°$ would give the same results as shown by the vector diagram and table of Fig. 10-8.

The four reference phases used in the eight-phase receivers just described can be derived from a delay network with two outputs having a quadrature relationship. Figure 10-9 shows a method of doing this with resistance summing networks. This method also provides a simple means of adapting a receiver to operate at a different carrier frequency without redesign of the basic delay and phase-splitting network. Any desired reference phase can be obtained by the proper choice of summing resistors.

A shift in carrier frequency at the receiver results in a phase rotation of the delay-network references. The amount of phase rotation is determined by the slope of the phase-frequency characteristic, which is directly related to the network delay. If this rotation is not corrected,

CHAPTER 11

COMPARISONS OF MODULATION METHODS

The preceding chapters have described the characteristics of various modulation methods that are used for data communication. The decision as to which method is best depends on the specific circumstances of use. For example, the choice may be based on simplicity of instrumentation or on tolerance to specific transmission impairments rather than signal-to-noise performance. Interaction with other services sharing the same facility may also be an important consideration. The more important advantages and disadvantages of the various methods will be discussed.

11-1 PERFORMANCE IN PRESENCE OF GAUSSIAN NOISE

We have shown that for fixed average transmitter power the error rate in the presence of flat gaussian noise is minimized by the use of a cosine-shaped receiving filter with a transmitted signal shaped to give a raised-cosine spectrum at the detector input. We have also shown that the same optimum results are obtained when the spectrum has a sharper cutoff provided the cutoff is shaped as illustrated in Fig. 11-1. For double-sideband carrier systems the shapings shown apply to both sidebands. In each example the spectrum at the detector input retains the symmetry condition for no intersymbol interference. With a flat noise spectrum the same noise power is accepted by each of the receiving filters. Also the signal amplitude at the detector input is the same in each case. Consequently, the same optimum performance is obtained for the various shapings shown in Fig. 11-1.

A good measure of performance is the required ratio of average transmitted power to the noise power in the Nyquist band to achieve a given probability of bit error such as 10^{-4}. Another measure of performance is the speed of transmission in bits per second per cycle of this band. For double-sideband systems where the maximum number of symbols per second is equal to the nominal band in cycles per second, the signal-to-noise ratio described is sometimes stated as

the average signal energy per symbol to the noise power per cycle of bandwidth.

Table 11-1 compares various systems on a fixed bandwidth basis as just described. For the multilevel cases it is assumed that the symbols are assigned binary designations in a cyclic or Gray code so

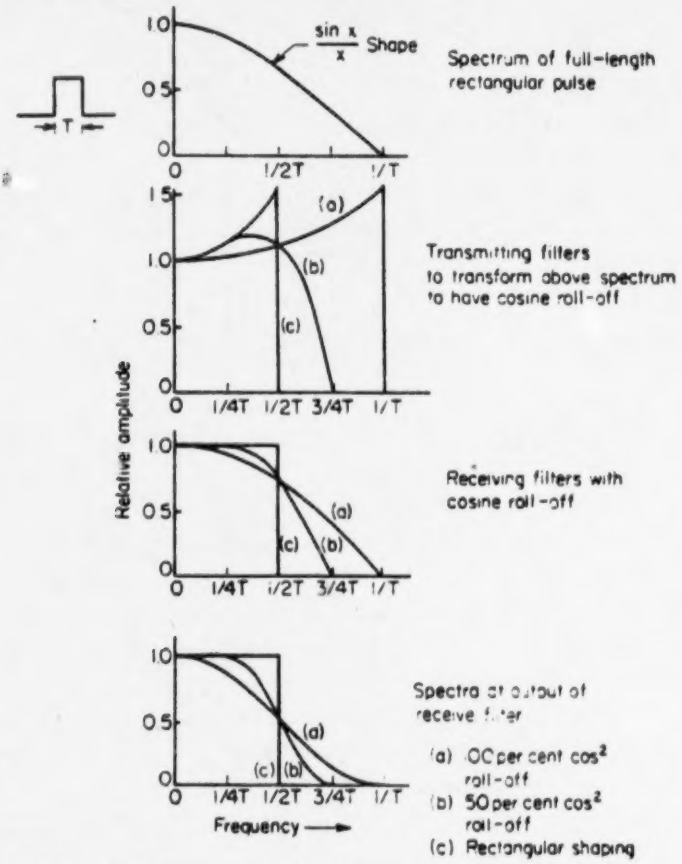


FIG. 11-1. Examples of optimum filtering in presence of flat gaussian noise.

that adjacent states differ by only one bit, as discussed in Sec. 7-6. The limitation on transmitted power in some cases may be set by peak power rather than average power. Table 11-1 also gives the signal-to-noise ratio on the basis of fixed maximum steady-state power. This might apply for systems which in an idle condition remain in the maximum-amplitude state.

The data of Table 11-1, based on average power, are plotted as points in Fig. 11-2. The horizontal coordinate gives the signal-to-noise ratio for a bit error rate of 10^{-4} and the vertical coordinate the transmission speed in bits per second per cycle of bandwidth. Such a diagram displays the various ways in which a channel with a given

signal-to-noise ratio can be used. If one is interested in comparing on a fixed bit-speed basis, the signal-to-noise figures need to be corrected according to the bandwidth ratio. For instance, in comparing a quaternary phase-modulation system with a binary phase-modulation

Table 11-1. Comparisons of Various Data Systems Under Limitations of Average and Maximum Steady-state Signal Power

System	Number of states	Speed in bits per second per cycle of bandwidth	Signal-to-noise ratio for 10^{-4} bit error rate	
			Average signal power	Maximum steady-state signal power
Unipolar baseband	2	2	14.4	17.4
	4	4	22.8	26.9
Bipolar baseband	2	2	14.4	17.4
Polar baseband	2	2	11.4	11.4
	4	4	18.3	20.8
	8	6	24.3	28.0
	16	8	30.2	34.4
Full carrier AM:				
envelope detection	2	1	11.9	14.9
coherent detection	2	1	11.4	14.4
	4	2	19.8	23.8
	8	3	26.5	31.0
Suppressed carrier AM, coherent detection	2	1	8.4	8.4
	4	2	15.3	17.8
	8	3	21.3	25.0
	16	4	27.2	31.4
PM, coherent detection	2	1	8.4	8.4
	4	2	11.4	11.4
	8	3	16.5	16.5
	16	4	22.1	22.1
	32	5	28.1	28.1
	64	6	34.1	34.1
PM, diff. detection	2	1	9.3	9.3
	4	2	13.7	13.7
	8	3	19.5	19.5
FM	2	1	11.7	11.7
	4	2	21.1	21.1
	8	3	28.3	28.3
VSB, 50% modulation	2	2	16.2	17.9

VSB, suppressed carrier, coherent detection (see polar baseband)
Quadrature AM, suppressed carrier, coherent detection (see polar baseband)

system at equal bit rates, the quaternary system would require but half as much bandwidth. With coherent detection the two systems become equal when the 3-db correction is made, and each requires a signal-to-noise ratio of 8.4 db for an error rate of 10^{-4}.

It must be pointed out that Fig. 11-2 indicates the theoretical performance of perfectly implemented systems with optimum signal shaping and filtering. Actual systems might well be poorer by one or

more decibels. Also where synchronous or coherent detection is assumed at the receiver, a practical system would usually devote some signal power to maintain the coherent reference carrier.

It will be seen that vestigial sideband and quadrature AM with carrier suppressed give the same result as polar baseband and have the best signal-to-noise performance, particularly if more than 2 bits

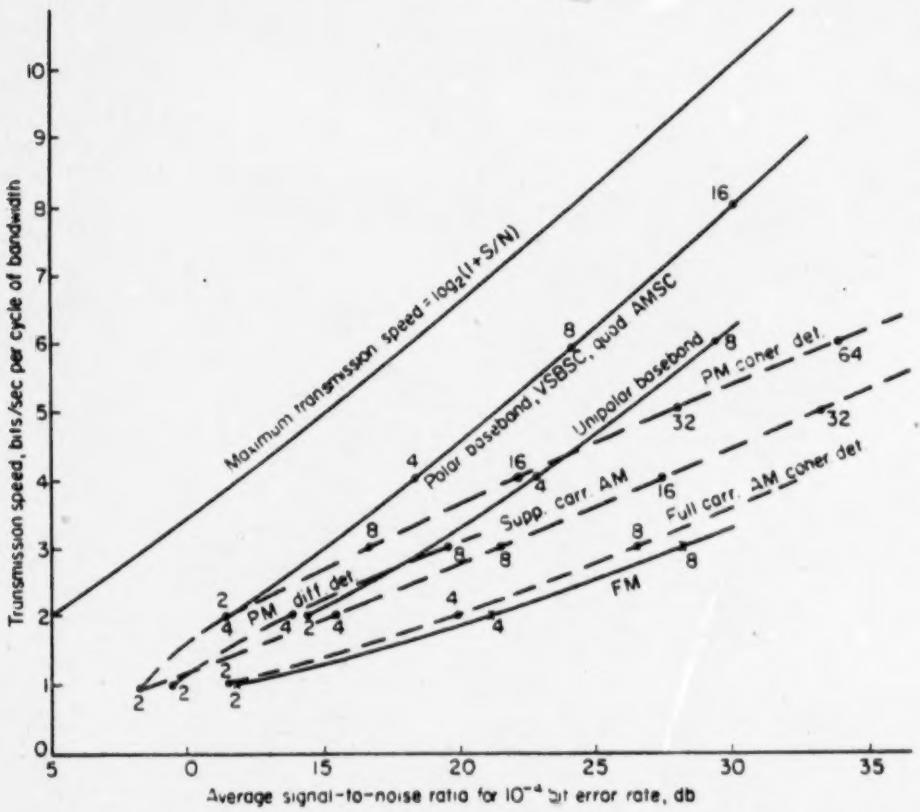


FIG. 11-2. Comparisons of various data systems under an average signal power limitation.

per cycle of bandwidth are to be obtained. It will be noted that they approach within about 7 db of the Shannon limit shown in the figure and discussed more fully in Chap. 18. The binary phase-modulation system can stand the most noise but achieves a capacity of only one-third of the limit. On the other hand, an 8-level VSB system, making use of a high signal-to-noise ratio, achieves a capacity of about three-fourths of the limit. Binary vestigial sideband, two binary AM channels in quadrature, and quaternary phase modulation give equal results. For a greater number of phases than four, the phase-modulation systems are seen to fall along a line that diverges

considerably from vestigial sideband and quadrature AM. This difference indicates the advantage of utilizing both phase and amplitude.[1] Phase-modulation systems using differential phase detection suffer an additional loss of 1 to 3 db.

Two-level suppressed-carrier AM is equivalent to binary phase modulation. For larger numbers of levels, the suppressed-carrier AM systems fall along a line which becomes displaced from the PM systems

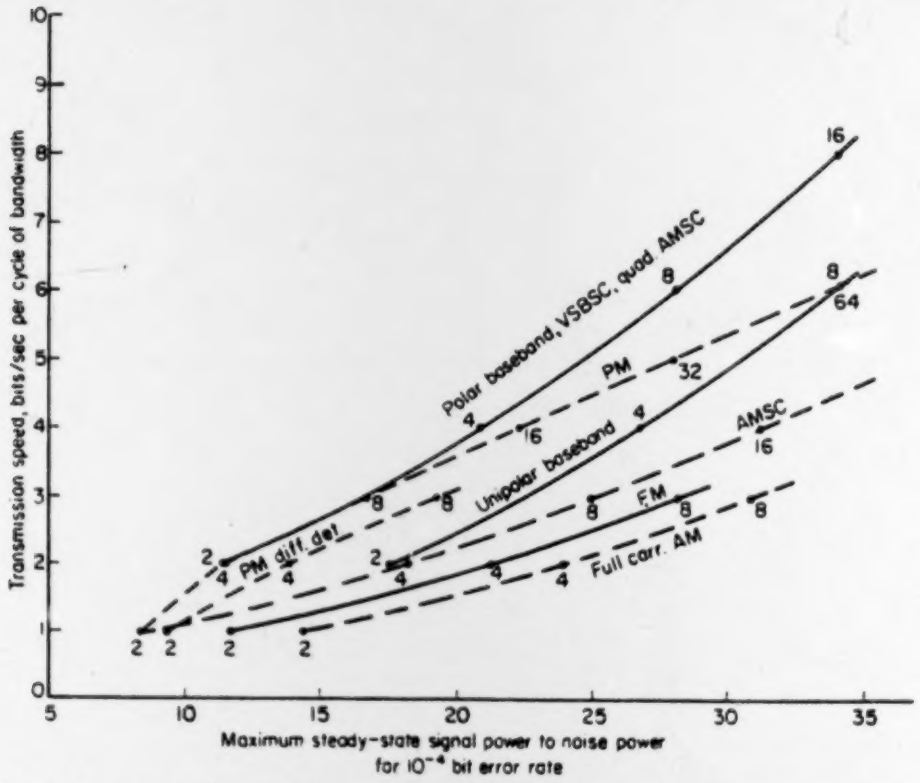


FIG. 11-3. Comparisons of various data systems under a maximum steady-state power limitation.

toward higher signal-to-noise ratios by about 5 db. For AM systems which transmit the full carrier, the line is moved from 3 to 6 db more toward higher signal-to-noise ratios. If envelope detection is employed, an additional loss occurs which for the binary case is 0.5 db. FM systems are seen to fall close to the full-carrier AM systems.

The data of Table 11-1 based on maximum steady-state power are shown in a similar manner in Fig. 11-3. The FM and PM systems remain as before. The variable-amplitude systems are shifted toward higher signal-to-noise ratios because of the reduced average power. Consequently, the constant-power signals show to better advantage.